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MISSOURI BOTANICAL GARDEN BULLETIN

VOLUME XXVIII

WITH 19 PLATES AND
36 TEXT-FIGURES

1940

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Missouri Botanical Garden Bulletin

Vol. XXVIII JANUARY, 1940 No. 1

FIFTY-FIRST ANNUAL REPORT OF THE DIRECTOR

To the Board of Trustees:

The Director of the Garden has the honor to submit his report for the year 1939.

In anticipation of the celebration of the twenty-fifth anniversary of the Garden in October 1914, an elaborate scientific program was arranged a year in advance. One of the most distinguished groups of European botanists ever to be assembled for such an occasion planned to be present and read papers. With a few exceptions all of these scientists were prevented by the war from attending.

October 1939 was the date for the fiftieth anniversary celebration of the founding of the Garden, and it would have again afforded a fitting time to bring together outstanding botanists and horticulturists of the world. For financial reasons it seemed advisable to forego any such recognition of the occasion as was arranged for the twenty-fifth anniversary. Fortunately for the Garden, but most unfortunately for the world, another war intervened and any comprehensive program would have had to be abandoned.

While no formal celebration was held in the fiftieth anniversary year, as was twenty-five years ago, 1939 will always be distinguished for the tangible recognition by its many friends of the place the Garden holds in the community and the state. Early in the year the public was informed that the sole sources of income, the real estate and investments of the Henry Shaw estate, were no longer adequate for the proper support of the Missouri Botanical

Garden. For the first time in its history an opportunity was afforded the public to assist in its maintenance and development. The special need at the time was for the improvement of the 1,600-acre Arboretum, located thirty-five miles southwest of the city. Fifty thousand dollars was estimated as necessary to complete the roads, build bridges, a large reservoir for fire protection and numerous other items, before the public could be admitted. In addition a fund was desired for the immediate maintenance of the Arboretum, after the necessary improvements were completed. Contribution to this latter fund, to be known as the "Friends of the Garden" fund, it is hoped will become an annual affair, and $25,000 was set as the goal to be reached as soon as possible. Such satisfactory progress was made in securing the improvement fund, which amounted to $43,745 at the end of the year, that by June it was possible to begin making definite plans. Elsewhere in this report is summarized what has been accomplished during the last six months. It is earnestly hoped that the balance of the necessary $50,000 may be obtained shortly in order that the Arboretum may be open to visitors, at least at stated times, in the spring or early summer of 1940.

The "Friends of the Garden" fund amounted to $6,871.73, as of December 31. This sum, made up chiefly of small gifts, represents the widespread interest in the Garden throughout the state. A large proportion of the garden clubs of Missouri have made donations, and the St. Louis Garden Club held a pilgrimage to twenty-two of the gardens of its members, which resulted in the largest single subscription from any club. It is a pleasure to list the names of those who have contributed to the improvement or maintenance of the Garden in any way during 1939.

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Group 8
Group 9
Group 11
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While the Garden has not been eligible for Federal aid of any kind, a project of the W.P.A. outside the Garden has resulted in one of the greatest improvements that has been made in years, so far as the safety and comfort of visitors are concerned. At the time the stone wall was built by Henry Shaw, along the east frontage of the Garden, the street had not been improved. The grade of Tower Grove Avenue as finally made was as much as four feet below the sidewalk in some places. This left an embankment impossible to climb in bad weather and most difficult at all times. Drivers of automobiles were frequently compelled to get out into the street and walk for some distance exposed to the hazard of passing machines. Probably more complaints from visitors were received because of the serious difficulty of parking along Tower Grove Avenue than from any other single cause. The obvious remedy was to move the sidewalk to the curb, leaving any necessary embankment between the sidewalk and the stone wall. This necessitated the removal of the old trees, chiefly maples, which had not only outlived their usefulness but as developed were positively dangerous to passers-by because of the decayed condition of their large limbs and trunks. Furthermore, trucks frequently broke off branches extending into the street, and the roots had raised the concrete slabs of the sidewalk causing many irregularities which were additional sources of accidents.

The removal of these trees, skillfully accomplished by the City Forester, demonstrated that, in addition to the many benefits obtained, they were not even greatly missed. The trees planted just inside the Garden overhang the stone wall and offset any effect of bareness. Present plans provide for a more careful selection of trees for this location, and with the addition of selected specimens to be used outside the wall, the appearance of the entire frontage along Tower Grove Avenue will within a short time be more attractive than was possible before. That the old practice of planting trees between the sidewalk and the curb has become obsolete is indicated by the following quotation from *Horticulture* (Feb. 19, 1939), under the title, "New Life for Street Trees."

"The planting of shade trees along the roads is a custom which dates back to the early settlers. At that time, and for many years afterward,

trees were considered a necessary source of shade for pedestrians and horse-drawn vehicles. Then came the automobile, bringing many changing conditions, some of which have affected our trees, often to their disadvantage.

"The extensive use of the automobile and the ever-extending water, sewer and gas mains have been contributing causes for much of the damage to street trees. Overhead electric wires, as well as hard-surfaced roads and sidewalks, have also done their share to weaken the physical structures of the trees and make them more susceptible to insect and disease infestation.

"A recent bulletin of the Massachusetts Forest and Park Association points out *that the space between the sidewalk and the traveled way on most streets is not a suitable place to plant shade trees.* It is called too narrow for the proper preparation of the soil without provision for the adequate seepage of moisture. Obviously, too, it hinders the proper development of the roots. In addition, trees which are planted in this area are subject to injury and mutilation by automobiles, animals and children. Moreover, roots are cut off whenever water, gas or sewer mains are laid or repaired, and the curbstones restrict their growth.

"*To correct some of these obvious faults, it is now recommended that shade trees be planted inside the sidewalk and on private property if necessary.* In some states, the statutes have been so drawn up that a property owner may sign a certain form which allows the local tree warden to plant a municipally owned tree on his property providing that it is not more than 20 feet from the property line. There is no expense of transplanting or maintenance levied on the property owner and he may, at any time, order the removal of the tree.

"If the trees stand inside the sidewalk, there is much less danger of their being injured by automobiles; their roots will not be restricted so much by curbstones nor damaged by trenches for water mains; and the open lawn surrounding them will allow more moisture to reach their roots."

THE ARBORETUM

Through the generosity of the many public-spirited citizens, both in St. Louis and elsewhere, interested in the development of the Arboretum, a substantial beginning has been made towards opening this new tract to visitors. Under favorable conditions this should be some time during the coming year. The work has been under the supervision of Mr. A. P. Beilmann, Arboriculturist to the Garden.

A reservoir, 106 feet long and 76 feet wide and 10 feet deep, with a capacity of 300,000 gallons, was completed during the summer. All four sides slope, giving the bottom a dimension of 30 by 60 feet. It is planned to keep the reservoir filled during the winter, and the sloping sides should prevent injury by freezing. The purpose of the reservoir is twofold: to supply water

for irrigation, and in connection with a pipe line to furnish water for fire fighting.

To supply the reservoir with water a six-inch cast-iron water main was laid to a point near the Meramec River, a distance of nearly 3,000 feet. Four standard fire hydrants have been placed on this water-main to serve as outlets for irrigation, as well as for fire protection. Water is being taken from a shallow well near the river. This is a drilled well reaching to bedrock twenty-seven feet below the ground surface and cased with a ten-inch pipe to the top of the gravel strata which is fifteen feet deep. Inserted in this casing and extending through the gravel bed is an eight-inch screen of our own design, within which is the four-inch pipe leading to the pump. Since the well may be submerged during floods, provision has been made to seal the opening and remove the pump.

Two pumps are used to force the water to the reservoir 240 feet higher and 3,000 feet away. The first is a four-inch centrifugal pump mounted atop the well casing on a concrete base. This supplies a second pump 200 feet away and 15 feet higher, also mounted on a concrete base. Both pumps are powered by gasoline engines delivering a total of 36 horsepower, and their delivery is synchronized through the use of pressure and vacuum gauges. The capacity of the pumping system, at the low stage of the river this fall, was approximately 7,500 gallons per hour.

The pipe line follows "Ledge Ridge Trail," one of the four fire roads which have been completed. To the east is "Cliff Ridge Trail" and 1,200 feet to the west is "West Valley Trail"; these are all connected by an additional trail. This system serves as service roads and pedestrian walks, although their chief function is to facilitate the movement of fire-fighting equipment in the woods. The gravel surface, seven feet in width, should make these trails effective fire barriers. A length of nearly two and a half miles tends to subdivide this area and assist in localizing a fire.

River-run gravel was chosen as the least costly as well as the most natural and pleasant surfacing for the 10,150 feet of newly graded roads. The gravel was obtained from a bar near the river at the east edge of the property. Approximately 5,000 cubic yards

have been hauled, including some stock piled for future use. Nearly all grading of the roads was done by Garden equipment and crews. The main roads are thirty-six feet wide from the ditch on one side to that on the other, permitting a gravel surface for traffic of eighteen feet. Drainage of the roadsides is accomplished by sixteen culverts; those of vitrified tile range in size from twelve inches to thirty inches for the largest, while the four concrete box culverts are longer and larger. It is quite possible that additional culverts will be required during a very wet spring. It would be very difficult to estimate the amount of soil moved during the road-making operations. The roads have been made without disturbance of the near-by hills and slopes, thus preserving the desired landscape effect. To make them look natural, far more grading was done than is usually necessary or practical in road-building.

Work was begun in December on two bridges across Brush Creek. It is hoped that they will be completed in the early spring of 1940. These bridges, constructed of steel and concrete, have a clear span of forty feet, and are alike in design. Bridge No. 1 will have a four-foot dam placed between the breast walls, designed to impound water for irrigation and fire protection at this point. Bridge No. 2, because of the conditions encountered during excavation, will be constructed without the dam at the bridge site. It is proposed to place a dam two hundred feet downstream, forming the same type of pool at this location. Brush Creek, on account of its steep gradient, is nearly dry for most of the summer, but for the same reason often carries "flash" floods during rainstorms. Therefore the new bridges are about forty per cent longer than the old bridge, and the creek at the bridge site will be widened to provide a greater cross-section in case of floods.

While much of the construction work is under contract, such items as trail clearing, cutting and clearing right-of-ways, culvert installation, sodding of reservoir slopes, etc., is being done by the Garden crew. The water, both for mixing and curing concrete, was hauled in our tank truck; de-watering the bridge excavations was accomplished with our own pumps. Our own compressor, air drills and tools were used in the rock excavating for both Bridge No. 1 and the reservoir. This arrangement has

lessened the cost of the work, since it was reflected in the contract prices.

Apart from the fundamental construction work referred to above, various items of repair and upkeep were necessary. The head house of the orchid range and the engineer's house were each re-roofed. The old barn, near the farm house, was wrecked and the lumber from it stored; the old roads were regularly graded and kept in repair; several miles of old wire fencing were removed, and numerous minor items of repair attended to.

In addition to the maintenance of the nursery, cold-frames, seed-beds, orchards, other plantations, etc., an area of approximately eighteen acres was cultivated, limed and seeded to blue grass. The old nursery was sown to cow-peas in the spring, later plowed under and sown to rye. One thousand trees and shrubs, including 335 magnolias and 100 conifers, were removed from the nursery to permanent locations and approximately 1,200 trees and shrubs, including 200 peonies, were transferred from the old to the new nursery.

Orchids.—During the year 10,598 plants were repotted, and orchid flowers, either cut or displayed on the plants, numbered 39,000. Of the Cattleya group, including both hybrids and species, 9,214 flowers were shown. The Cypripediums produced 1,701 flowers, Cymbidiums 1,375 flowers, *Dendrobium Phalaenopsis* 708 spikes (2,852 flowers), *Dendrobium nobile* hybrids 757 plants (7,570 flowers), Oncidiums 458 spikes (11,450 flowers), botanical species 486 spikes (4,860 flowers).

The orchids grown in the Plant Curiosity House (at the city Garden) have given an added display of flowers, as well as an opportunity of showing how the plants grow naturally. The Cattleya group produced 314 flowers, Phalaenopsis (moth orchid) 140 flowers, *Oncidium varicosum* 125 flowers, Cypripedium 47 flowers, totaling 626 flowers for the year.

Sunshine Record.—This record, as in the past, continues to show the advantage to plants of living outside the city. During the nine years in which these comparative readings have been published, the number of hours of sunshine at the Arboretum, particularly during the winter months, has always been in excess of that at the Garden in St. Louis:

Month	*City Garden*	*Arboretum*
January	87	122
February	104	125
March	171	194
April	174	186
May	270	274
June	240	244
July	283	298
August	260	273
September	291	278
October	233	246
November	99	126
December	98	132
	2,310	2,498
		2,310
Excess of sunshine hours at Arboretum		188

ADDITIONAL CONSTRUCTION AND REPAIRS

While the work at the Arboretum has constituted the main construction item, various minor improvements and replacements in the city Garden have received attention.

As was the case last year, the heating plant, now twenty-five years old, has needed unusual attention. All three boilers were retubed, requiring 370 tubes, 18 feet long. New brick walls and new tiling were supplied where necessary. Some 1,500 feet of heating pipe were rearranged, and 250 feet of water pipe supplied in the experimental greenhouse. The entire heating and water systems were overhauled, including replacing valves, repairing steam traps, new gaskets, etc., all necessary to keep this most important branch of the service department in perfect condition.

In order to provide room for the greatly enlarged amateur garden classes, one wing of the experimental greenhouse was entirely remodeled. New and enlarged concrete growing benches were built to furnish working space for one hundred or more students. The basement has been refinished to serve as a lecture room. A portion of the south wing was converted into an orchid-seedling house and the steam sterilizer removed from the laboratory to a more convenient location in the head-house. A new gas line was run from the administration building to supply this sterilizer.

The north house of this range was supplied with new mullions and reglazed. Because of the necessity of supplying new mullions

for the south house, advantage was taken of an opportunity to try an experiment with a new product designed as a substitute for glass. Plants grown in this house will be checked with those under glass to see if there is any advantage from the supposed passage of ultra-violet rays.

The usual amount of painting and of general upkeep of the buildings and grounds has been attended to. Mention should be made of salvaging some 1,800 feet of six-inch cast-iron water pipe, dug from an abandoned water main in the North American tract. This supplied more than half the pipe needed for the line installed at the Arboretum to carry water from the well at the river to the new reservoir.

EXPERIMENTAL GREENHOUSES

The improvements and changes in this range, referred to above, should make it possible to carry on the experimental work, as well as the amateur classes, more satisfactorily than in the past. Some of the activities now conducted in this range under the direction of Dr. D. C. Fairburn, Horticulturist to the Garden, are:

1. *Orchid Seedlings.*—The culture of hybrid orchid seedlings is again of importance in maintaining the orchid collection at the Arboretum. Plants are being raised by the symbiotic and asymbiotic method, using various culture media.

2. *Plant Propagation.*—Numerous cuttings of woody and herbaceous plants were rooted, using both root-promoting chemicals and vitamin B. The rooting of rhododendrons by leaf-bud cuttings is also being investigated. Some 300 kinds of seed, including new or unusual annuals and perennials, were sown. Particular attention is being paid to raising from seed various species of Magnolia, including *M. grandiflora, M. glauca, M. Soulangeana,* and *M. stellata.*

3. *Plant Breeding.*—In addition to the breeding of water-lilies, carried on by Mr. G. H. Pring, Superintendent of the Garden, work is being done by Dr. Fairburn toward developing an improved geranium for St. Louis. Several hundred seedlings have been selected from crosses made previously. These seedlings made a satisfactory showing in the nursery, many of them having thirty or more heads of flowers and abundant all-round vigor. Crosses

between commercial varieties of Penstemon and native species give promise.

4. *Plant Nutrition.*—Extensive tests to determine the comparative growth of plants in various media, sterilized and unsterilized, have been made in order to check recent investigations made along this line elsewhere.

5. *Advanced Course in Gardening.*—Class members raised over 5,000 seedlings of various annuals and perennials, and rooted about 5,000 cuttings of more than 50 kinds of plants. Tulips, hyacinths, lilies-of-the-valley, gladiolus, and other bulbous plants were also raised.

MAIN CONSERVATORIES AND EXOTIC RANGES

The large xerophytic collection at the Garden attracts many visitors to the two Desert Houses. Only within the last decade have the cacti and other succulents assumed such an important position in the garden world; yet these strange plants of desert, mountain, canyon, and mesa have been more or less in vogue for nearly three centuries. Visiting cactus enthusiasts pronounce the Garden collection of succulents to be outstanding.

All the various methods of plant propagation have been carried on, as in former years, and many new species were added by germinating seed. More attention has been given to grafting, for this form of propagation aids in "accelerating" the growth of slow-growing species. The oldest graft on exhibit, *Monvillea Cavendishii,* which was made in 1923, has now reached the roof. It has become a most prolific bloomer, producing flowers from early April to late September.

The annual trek to the southwestern deserts by Ladislaus Cutak, in charge of Succulents at the Garden, has netted several outstanding specimens for the collection, while valuable data and photographs were secured on the Mexican cacti. A full report of this trip appeared in the September BULLETIN.

Initial-carving culprits have transferred their vandalistic acts to the palms, and two of the fan-leaved palmettos have been seriously scarred. Almost all the ground area in the Palm House is now covered by the creeping pepper plants. *Saguerus (Arenga) mindorensis,* one of the sugar palms received from the United

States Department of Agriculture in 1916, bloomed for the first time in December. Several small clumps of Marica, a tropical plant related to the iris, were planted under the palms and thrive exceedingly well. The blooms are very showy but last only a day. Maricas make excellent house plants.

The beds in the Fern-Cycad House were replanted with Nephrolepis ferns, which make a fine ground cover. The Ceriman, or *Monstera deliciosa,* an ornamental vine, evokes more comment perhaps than any other plant in the house. It is a vigorous, straggling climber with immense, broad, long-petioled, perforated and scalloped leaves that attain a length of two feet or more. Its unusual long cone-like fruits are very delicious, but it takes about ten months for the fruit to ripen, and usually some visitor snips it before it has a chance to mature.

The banana plants unfurled their purple buds beneath the clusters of green fruit, and there was an exceptionally good crop during the past year. The coffee trees likewise brightened the scene with their cherry-like berries. These two most useful plants always hold a special attraction for the visitors, particularly school children.

In the Citrus House several outstanding lianas held the spotlight during their flowering season. The most floriferous were *Petrea volubilis,* the Queen's Wreath, with very attractive racemes of mauve and blue flowers, and *Anemopaegma Chamberlaynii,* producing a wealth of striking pendulous clusters of yellowish blossoms.

Two of the alcoves in the Aroid House were entirely renovated and the old plant material replaced with ornamental foliage plants. Several of the shrubby, free-flowering *Clerodendron fallax* were added to the tropical plantings, enhancing the luxuriant verdure with flame-spattered clusters of brilliant flowers.

FLORAL DISPLAYS

Much of the outdoor gardening, as well as the special shows in the Floral Display House, are managed and arranged by Mr. Paul A. Kohl, Floriculturist to the Garden. Abundant rains and cool weather during the first part of the summer afforded all plants an ideal growing season. Although a protracted dry spell

started in late August, it came too late to injure seriously any trees or shrubs. However, shallow-rooted plants and particularly evergreens had to be watered until late in the fall. With this good weather all of the plants in the various gardens responded with a fine display of flowers, and we had the feeling that for once the weather approximated that of England which we like to think has the ideal climate for most plants.

Indoor Displays.—The indoor floral displays were continued in the same manner as in previous years. The orchid show was ready February 4 and again the shadow-boxes were used. The next important display was the 2,500-foot azalea garden in the center of the Arena for the Greater St. Louis Flower and Garden Show, held from March 18 to 26. At the Garden the cineraria show opened March 26. The hydrangeas were displayed April 30, and on the same Sunday 230 flowering plants were sent to Christ Church Cathedral for the annual flower sermon. The St. Louis Horticultural Society held its spring show on May 20 and 21, and on May 26 the pelargoniums and caladiums were displayed. After the summer intermission the St. Louis Horticultural Society held its dahlia show on September 30 and October 1, and on October 12 the Veiled Prophet Queen's bouquet was exhibited for a day. The chrysanthemum show lasted from November 5 to December 3, and on December 10 the poinsettias were exhibited in combination with chrysanthemums, stevias and begonias.

For insect control 1,000 gallons of spray material are used in the floral display department each year. In August the small hand-operated sprayer was replaced by an electrically operated pump which has greatly increased the efficiency of the spraying program.

TRANSFER OF TROPICAL STATION

The tropical station, maintained at Balboa, C. Z., for the past twelve years, was transferred to the Canal Zone Government in March, 1939. It was a matter of regret that for financial reasons this became necessary, since the Station has from the first formed a most useful adjunct to the activities of the St. Louis Garden. Fortunately, Mr. Paul Allen, the former manager of the Station, decided to remain on the Zone and has since been appointed Horticulturist at the Summit Garden. This makes it possible for

Mr. Allen to continue to represent the Garden in the tropics. He will be able, not only to maintain the old station as an attraction for Canal Zone visitors, but will likewise give the Garden the benefit of his wide experience in collecting plants for the proposed "Flora of Panama," a project in which considerable progress has already been made.

SUPERVISED INSTRUCTION FOR SCHOOL CHILDREN

The work with school children, under the supervision of Miss Clara M. Heising, Special Nature Study Teacher, assigned to the Garden by the Board of Education, has continued as in former years. More than 8,000 pupils of elementary and high schools have had lessons on plants, including flowers, trees and fruits, also birds, insects and other creatures. Frequently the weather was also discussed, especially when some interesting or unusual phenomena were visible.

Whenever possible, the lesson was correlated with the work in social studies, affording the pupils a clearer knowledge of the flora of certain regions and therefore a better understanding of the home life and problems of the inhabitants of those particular areas. Nature lessons in the Garden frequently provided subjects for art and craft lessons, and motivation for language and English, particularly composition, letter-writing and public speaking. Lists of guiding questions to stimulate interest in, and observation of, living things in their home and school environment were given to teachers accompanying the classes.

High-school classes came for lessons in physiography, conservation, pollination, and inter-relation between plants and insects. As an experiment, several kindergarten classes came for field trips.

To classes of elementary schools were given lessons on plants, stressing: 1—their growth and development; 2—their response to proper care under the watchful eye of experts here; 3—their adaptation to particular types of environment and climate; 4—how certain plants are provided with the means of gathering an extra supply of moisture from the air; 5—the unique insect traps of the Venus flytrap and pitcher plants; 6—how plants overcome certain difficulties that arise; 7—competition among plants to obtain the maximum amount of light; 8—the beauties of the growth

of buds, leaves and flowers; 9—how to beautify even a small yard by planning the garden carefully; 10—Nature's way of reproducing plants; 11—Man's methods of propagation of plants; 12—seed dispersal; 13—Nature's way of protecting plants over winter; 14—Man's methods of protecting plants when necessary; 15—leaves, particularly the gorgeous autumn leaves here; 16—galls; 17—how to become acquainted with our native plants; 18—how to recognize our state flower, the hawthorn; 19—the art of arranging flowers and plants to produce pleasing effects as exemplified throughout the Garden both outdoors and in greenhouses; 20—the proper way to smell a flower; 21—how to observe and enjoy flowers *without* plucking them; 22—the loss of a plant's "little children" when somebody picks a flower; 23—conservation of wild flowers; 24—how Nature tries to heal or repair plant injuries; 25—results of thoughtless mutilation of plants; 26—the growth of a tree; 27—how a tree accommodates itself to its neighbors; 28—co-operation among plants; 29—how to read a twig's story.

Whenever birds were observed or heard, a brief lesson was immediately given to create and stimulate interest in birds. The inter-relation of plant, insect and bird life was stressed, and in that connection insect study was pursued whenever: 1—injurious insects or their depredations were observed; 2—beneficial insects or their eggs were seen; 3—ants were observed—their co-operation for the welfare of the colony; 4—bees were seen visiting flowers and paying for their meal; 5—honeydew was observed; 6—bagworms and other cocoons were discovered; 7—grasshoppers were seen; 8—leaf-rollers were observed in their "lairs," and also when sparrows were seen twitching them out of their neat little "rolls" and devouring them.

The following are some of the objectives in mind when planning lessons: 1—that a beautiful garden is not only a joy to the person who plans and work in it, but it is an inspiration to one's neighbors and all who see it; 2—an appreciation of color harmony and beauty as exemplified by the beautiful floral displays and also by the arrangement, growth and development of plants outdoors; 3—recognition of many of our common flowering plants; 4—realization that a plant is actually a living, growing thing;

5—a knowledge of conditions necessary to the growth of certain crops. (Project work with materials from the economic garden not only helped pupils to learn the use of reference books at school and home, but gave them a better understanding of industries essential to their daily comforts, and a growing interest in the life and work of the farmer, the miller, and the manufacturer. Much interest centered in the soy bean.); 6—a realization of how dependent we are upon others; 7—a growing interest in life about one; 8—an interest in the changing seasons; 9—an appreciation of the beauty as well as the usefulness of a tree; 10—realization that a tree is a living, growing thing and needs protection; 11—development of keen observation, keen sense of hearing, as well as the ability to report accurately what one observes; 12—realization that only through the splendid co-operation of all workmen here can the beautiful displays and lovely vistas enjoyed by the class be made possible.

Individual pupils, as well as teachers and classes, have written letters of appreciation, telling how much their visit to the Garden has meant. Last spring and this fall many children attended early morning "Bird Walks" and "Nature Walks." After school hours, there were also frequent nature walks with adults, particularly girl scout leaders who came for work in "Creative Nature Study."

RESEARCH AND INSTRUCTION

Dr. J. M. Greenman, Curator of the Herbarium and Professor in the Henry Shaw School of Botany of Washington University, has devoted most of his time and energy during the year to curatorial duties of the herbarium. In addition to these exacting duties, he has continued to direct the research work of the graduate students in taxonomy; he has also given advanced courses in comparative morphology and taxonomy of ferns and flowering plants, as listed in the catalogues of Washington University.

Dr. Greenman, in the limited time available, has also continued research on various groups of flowering plants, and on monographic and floristic projects of several years' standing.

Dr. C. W. Dodge, Mycologist to the Garden and Professor in the Henry Shaw School of Botany of Washington University,

spent the early part of the year in routine determination of many small series of lichens, mostly from tropical regions. Mr. Timothy Murphy has assisted in the preparation of microscopic slides, and Mr. Donald F. Flint and Mrs. E. C. Berry have aided in clerical work and in the insertion of specimens in the lichen and fungus herbaria. A large series of specimens of Panamanian and Costa Rican polypores collected by Dr. Dodge have been identified by Dr. J. A. Stevenson, of the Mycological Collections of the U. S. Department of Agriculture, and are being inserted in the herbarium. Miss Margaret Fulford, of the University of Cincinnati, has identified a large series of hepaticae from British Honduras.

During the summer, a large series of antarctic and subantarctic lichens have been received from Sir Douglas Mawson, Rector of the University of Adelaide. These consist of collections of the northern party of the British Antarctic Expedition under Shackleton 1907-09, from the west coast of Ross Sea in South Victoria Land; collections of the Australian Antarctic Expedition 1911-14, under Mawson from Adélie, King George V and Kaiser Wilhelm II Lands, and Macquarie Island; and collections of the British Australian New Zealand Antarctic Research Expeditions in the *Discovery* 1929-31, from Enderby, MacRobertson (Lars Christensen) and King George V Lands, as well as the subantarctic islands: Possession Island of the Crozet group, Kerguelen, Heard Island and Macquarie Island. The autumn has been spent in sorting and in a preliminary determination of this material.

Under a grant from the International Cancer Research Foundation, a study of the action of methyl cholanthrene and other carcinogens on *Saccharomyces ellipsoideus* has been continued. Dr. G. T. Johnson has served as research assistant on this project since September 15.

The usual courses of instruction and research have been given. Plant pathology has been given during the autumn. Dr. G. T. Johnson has offered general bacteriology in University College. Dr. Johnson completed his studies on the morphology and relationships of the Pyrenocarp lichens, especially the Trypetheliaceae. Mr. E. C. Berry is completing his monograph of the species of *Parmelia* of the western hemisphere north of Mexico. Miss Elizabeth Heuser, besides assisting in the course in general bac-

teriology, has continued her study of the morphology and cytology of *Gymnoascus sudans* Vailionis. Miss Jean E. Martin has undertaken a study of the effectiveness of the impregnation of leather with fungicides, at the request of a local shoe manufacturing company.

Dr. Edgar Anderson, Geneticist to the Garden and Engelmann Professor in the Henry Shaw School of Botany of Washington University, has continued to center his research upon the species problem, though with a definite shift of emphasis. Utilizing the insight into species differences which has been gained in previous studies, he is attempting by regular genetical techniques to analyze the total differences between the germ-plasms of related species. Such morphological differences are ultimately the outward reflection of an inherent difference in the germ-plasm, a difference compounded from various changes in structure and in chemical composition. When, therefore, the morphological differences between related species can be determined accurately enough, it should be possible to interpret the results of species crosses in terms of the protein chemistry of the related germ-plasms. While this goal has not yet been reached, or can scarcely be said to be in sight, a very definite advance has been made during the past year, and the work which is under way at the present time (largely with two species of *Nicotiana)* is even more encouraging.

A rough indication of the effectiveness of this general program of research is given by the extent to which work at other institutions is being carried out more or less under the direction of Dr. Anderson. Dr. H. P. Riley, of the University of Washington, completed and published two investigations on hybridization in *Tradescantia* and *Iris;* Dr. C. C. Epling, of the University of California, has well under way a study of variation in populations of *Yucca;* and Dr. N. C. Fassett, of the University of Wisconsin, is studying the comparative variability of species in relict and non-relict areas.

The integration of a research program of this character with the duties of a botanical school and a botanical garden would have been impossible without the expert assistance of Mr. Leslie Hubricht.

During the year considerable progress has been made in identifying the various outdoor collections at Gray Summit, principally

the conifers in the Pinetum and the large plantation of several hundred oriental flowering crab-apples. With the assistance of one of the graduate apprentices, Mr. Robert Clark, this is now virtually completed, and we are now beginning to build up these collections by purchases, exchanges, and (let us hope) donations. In the Pinetum, for instance, we are very much in need of the common Japanese white pine, *Pinus parvifolia,* which, while it is grown in several American collections, is not regularly offered in the trade. It is to be hoped that some friend of the Garden will be able to supply us with a few young plants.

Dr. Robert E. Woodson, Jr., Assistant Curator of the Herbarium and Assistant Professor in the Henry Shaw School of Botany of Washington University, has, as in previous years, spent the majority of his time with classes at the University. The elementary class, Botany 101, has continued to grow in interest to the undergraduate body, as evidenced by the registration, quality of work, number of students participating in the voluntary field trips, and number of those electing succeeding courses in botany. The work in this class during the past year has been facilitated greatly by the appointment of Dr. Henry N. Andrews (Ph.D. '39) as instructor in botany, in charge of the elementary laboratories. Dr. Andrews is also in charge of the classes in plant anatomy and microtechnique. He likewise continues studies in his special field, paleobotany. Graduate students acting as assistants in the elementary laboratory during the past year have been Elizabeth Ammermann, Edward L. Berry, Ralph W. Emons, Jean Elder Martin, and Ralph E. Rawlings.

The second year class, Botany 317, is designed as a survey course of the whole plant kingdom, exclusive of bacteria, especially as represented in the flora of Missouri. During the two semesters of 1939, a total of twenty-five students enrolled in this course, more than in any previous year. Six graduate students have undertaken research in morphology.

Dr. Woodson's research during the past year has centered chiefly about the preparation of a "Flora of Panama" and taxonomic studies in the Asclepiadaceae. Tentative plans have been made for the publication of the first volume of the "Flora," to deal with the Monocotyledonous families, in 1941. Several of the

most prominent botanists of America and Europe are contributing important sections of this project. During the year, approximately two thousand numbers of specimens have been received from Panama, chiefly due to the zeal of Mr. Paul H. Allen, the Garden's representative in Panama. The larger part of the routine classification of these collections has been facilitated greatly by the assistance of Mr. Robert W. Schery.

Graduates and Fellows.—The following appointments were made in the Henry Shaw School of Botany for the year 1939-1940:

Assistants in Botany (half-time assistants): Elizabeth Ammerman, A.B. and M.S., Washington University (Taxonomy and Morphology); Ralph E. Rawlings, B.S., University of Arkansas (Mycology and Taxonomy); (quarter-time assistant) Ralph W. Emons, A.B., Washington University (Morphology).

Washington University Fellowships: Ralph O. Erickson, A.B., Gustavus Adolphus College, St. Peter, Minn. (Taxonomy); Russell J. Seibert, A.B. and M.S., Washington University (Taxonomy and Morphology).

Jessie R. Barr Fellowship: Dorothy Irene Henson, B.S. in Ed., University of Missouri, M.S., University of Oklahoma (Morphology and Taxonomy).

Independent Students: Edward C. Berry, B.S. in Ed., State Teachers College, Warrensburg, Mo., M.A., University of Missouri (Mycology); William L. Brown, B.A., Bridgewater College, Bridgewater, Va. (Cytology and Taxonomy); Alexander Reyburn Gordon, Jr., A.B., Washington University (Morphology and Taxonomy); Elizabeth Jeannette Heuser, A.B., Washington University (Mycology).

Graduate Apprenticeships: Stanley Bettoney, B.S., Massachusetts State College (Cytology); Robert B. Clark, B.S., Massachusetts State College (Taxonomy and Morphology); Robert W. Schery, A.B., Washington University (Morphology and Taxonomy).

Degrees.—The following students in the Henry Shaw School of Botany received advanced degrees at the Washington University commencement in June: (Doctor of Philosophy) Henry N. Andrews, B.S., Massachusetts Institute of Technology, M.S.,

Washington University (Taxonomy and Morphology); Hugh Carson Cutler, B.A. and M.A., University of Wisconsin (Taxonomy); Mary Maxine Larisey, A.B. and M.S., Washington University (Taxonomy and Morphology); George Thomas Johnson, B.A., University of Arkansas, M.A., Washington University (Mycology and Taxonomy); Francis Marion Ownbey, B.A. and M.A., University of Wyoming (Taxonomy); (Master of Science) Elizabeth Ammerman, A.B., Washington University (Taxonomy and Morphology).

During the year, with the cooperation of Washington University, it has been possible to establish the graduate apprenticeships on a more definite basis. For a summer period of thirteen weeks these young men participate in the regular horticultural work of the Garden, while during the school year they work only three full days per week and spend the remainder of their time as half-time graduate students in Botany. Their wages, however, are equalized so that during the summer period and the school year, as well as during their two weeks' vacation, they are paid at the rate of $11.00 per week. The university, on its part, grants half tuition to these graduate apprentices, thereby making it possible to attract candidates of outstanding ability. While it is much too soon to estimate the ultimate success of this departure, it is now apparent that the plan has many attractive features. As the details of its administration become adjusted it should prove mutually advantageous to the Garden, the apprentices, and the University.

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Brown, William L.: Chromosome Complements of Five Species of *Poa* with an Analysis of Variation in *Poa pratensis*. Amer. Jour. Bot. **26:** 717–723. November, 1939.

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Cutler, Hugh C.: Monograph of the North American Species of the Genus Ephedra. Ann. Mo. Bot. Gard. **26:** 373–427. November, 1939.

Fairburn, David C.: The Culture of African Violets. Mo. Bot. Gard. Bull. **27:** 203–207. December, 1939; How to Force Hardy Bulbs. Mo. Bot. Gard. Bull. **27:** 137–145. September, 1939; Identification and Control of Common Plant Pests. Mo. Bot. Gard. Bull. **27:** 207–211. December, 1939.

Garland, Hereford: A Microscopic Study of Coniferous Wood in Relation to Its Strength Properties. Ann. Mo. Bot. Gard. **26:** 1–94. February, 1939.

Goddard, Mary: Studies on Variation in *Gibberella Saubinetii* (Mont.) Sacc. (*Fusarium graminearum* Schwabe). Ann. Mo. Bot. Gard. **26:** 99–164. April, 1939.

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Reynolds, Ernest S.: Tree Temperatures and Thermostasy. Ann. Mo. Bot. Gard. **26:** 165–255. September, 1939.

Seibert, R. J., with Robert E. Woodson, Jr. Contributions toward a Flora of Panama, III. Collections during the summer of 1938, chiefly by R. E. Woodson, Jr., P. H. Allen and R. J. Seibert. Ann. Mo. Bot. Gard. **26:** 265–324. November, 1939.

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tember, 1939; New or Otherwise Noteworthy Apocynaceae of Tropical America. VI. Ann. Mo. Bot. Gard. **26:** 95–98. April, 1939; *ibid.* VII. **26:** 257–259. November, 1939; Two New Asclepiads from the Western United States. *ibid.* 261–264. *figs. 1–2.* November, 1939; with R. J. Seibert: Contributions toward a Flora of Panama, III. Collections during the summer of 1938, chiefly by R. E. Woodson, Jr., P. H. Allen and R. J. Seibert. *ibid.* 265–324. November, 1939. Zingiberaceae, in A. C. Smith, Notes on a Collection of Plants from British Guiana. Lloydia **2:** 171-172. September, 1939.

Scientific and Popular Lectures.—

Dr. Henry N. Andrews, Instructor in the Shaw School of Botany: December 28, at Columbus, Ohio, paleobotanical section, Botanical Society of America, "A New Cupule from the Lower Carboniferous of Scotland, with a Note on the Morphological Significance of Paleozoic Cupules."

Dr. Edgar Anderson, Geneticist to the Garden: May 12, Federated Garden Clubs of Missouri, Jefferson City, "Something About Herbs"; May 15, St. Louis Flower Show Association, "Judging Amateur Classes."

Mr. A. P. Beilmann, Arboriculturist to the Garden: February 20, Good Earth Garden Club of Kirkwood, "Some Diseases of Shade Trees"; October 23, Louisiana Garden Club, Louisiana, Mo., "Trees and Their Care"; November 7, Ladue Garden Club, "Trees."

Mr. W. L. Brown, graduate student in the Shaw School of Botany: February 7, Greater St. Louis Association of Gardeners, "Lawn Problems of the Middle West"; and Edward C. Berry, graduate student in the Shaw School of Botany: December 29, at Columbus, Ohio, general section Botanical Society of America, "Abnormal Microsporogenesis in Tradescantia."

Mr. Ladislaus Cutak, in charge of Succulents at the Garden: January 12, St. Louis Florist Club, "Searching for Botanical Treasures in Texan Deserts"; February 3, Group 8 of the Webster Groves Garden Club, "Gardens of Virginia and Texas"; April 20, St. Boniface Holy Name Society, May 8, Nativity Holy Name Society, and May 10, Scottish Rite Club, "Exploring

Texas with Camera and Tripod"; June 13, Executives Club of St. Louis, and September 12, Holy Name Society of St. Pius' Church, "Along the Cactus Trail"; September 24, Chicago Cactus Society, at Chicago, Ill., "The Culture of Succulent Plants"; October 18, Kiwanis and Rotary Clubs, of Edwardsville, Ill., "Exploring for Plants"; November 4, Irwin M. Krohn Conservatory, Eden Park, Cincinnati, Ohio, "Cacti and Their Universal Appeal"; November 28, St. John Nepomuk Holy Name Society, "Along the Cactus Trail"; December 1, St. Louis Horticultural Society, "Cactus—Indoors and Out."

Dr. Carroll W. Dodge, Mycologist to the Garden: September 4, Third International Congress for Microbiology, at New York, "Some Effects of Carcinogenic Substances on *Saccharomyces ellipsoideus*."

Dr. David C. Fairburn, Horticulturist to the Garden: February 8, Delta Gamma Mother's Club, "House Plants"; April 7, College Club of St. Louis, "Spring Gardening"; September 21, Ferguson Garden Club, and November 15, Webster Groves Garden Club. "Bulbs."

Dr. J. M. Greenman, Curator of the Herbarium: December 28, at Columbus, Ohio, Presidential Address, American Society of Plant Taxonomists.

Mr. L. P. Jensen, Manager of the Garden Arboretum: April 7, Gray Summit School, "Planting and Care of Trees"; April 28, Washington Mo. grammar school, "The Value of Trees to Posterity"; May 19, Washington Mo. grammar school, "The Value of Trees to Man"; July 9, Meramec State Park, Sullivan, Mo., "Popular Interest in Botany"; August 22, Missouri State Fair, "Some Interesting Native Plants"; September 7, Garden Club of Washington, Mo., "The Activities of Garden Clubs in the Conservation of Native Plants."

Mr. Paul A. Kohl, Floriculturist to the Garden: February 21, Business Girls' League of the Y. W. C. A., "A Tour Through the Missouri Botanical Garden"; March 7, Triangle Alumni Association of St. Louis, "The Missouri Botanical Garden"; May 1, Northwoods Garden Club, "Landscaping the Home Grounds"; May 2, Ladue Garden Club, "Gardening"; October 6, St. Louis

Horticultural Society, "Growing and Displaying Chrysanthemums"; October 6, Musicians' Guild of St. Louis, "A Trip Through the Missouri Botanical Garden."

Dr. George T. Moore, Director of the Garden: April 4, Garden Club of Ladue, "Organizing a Garden Club"; September 25, Hawthorn Garden Club of Jefferson City, Mo.; December 27, science section, Wednesday Club, "The Plant:—the Greatest Chemist of Them All."

Mr. George H. Pring, Superintendent of the Garden: January 5, Men's Club of the Shaw Avenue Methodist Church, "The Romance of the Plant World"; February 6, Chicago Association of Gardeners, at Chicago, "The Breeding of Tropical Waterlilies"; February 9, Chicago Men's Garden Club, "Development of the Russell Lupines"; March 13, over Radio Station KXOK, "The Greater St. Louis Flower and Garden Show"; March 16 and March 21, over Station KSD, "The Greater St. Louis Flower and Garden Show"; March 31 and April 4, over Station KXOK, "Plant Collecting in Central and South America"; April 17, Business and Professional Club of St. John's Episcopalian Church, "Floral Displays at the Garden throughout the Year"; September 21, Ladies' Coterie of Granite City, Ill., "The Missouri Botanical Garden Arboretum"; October 3, interview over Radio Station KMOX, "Orchids for the Veiled Prophet Queen's Bouquet."

Mr. Russell J. Seibert, graduate student in the Shaw School of Botany: September 16, Shiloh Valley Grange, Belleville, Ill., "Plant Collecting in Panama"; September 20, Mascoutah Women's Club, Mascoutah, Ill., "The Romance of Panama."

Dr. Robert E. Woodson, Jr., Assistant Curator of the Herbarium: February 3, St. Louis Horticultural Society, "Panama."

HERBARIUM

It is a pleasure to record that a normal growth and expansion, accompanied by the many other activities incidental to an herbarium, have continued during the year. Marked progress has been made in the further organization of the general collections in order to bring them in accord with the treatment of recent monographs and other current publications—thus rendering the herbarium of greater usefulness as a reference medium for ob-

taining ready information concerning the identification, variation, and geographical distribution of species of plants.

Particular emphasis has been given to the acquisition of additional material to further amplify the representation of the flora of western United States, Mexico, Central and South America; although several important series of plants have been obtained to augment the Garden's representation of exotic floras. It is noteworthy also that an exceptionally large number of specimens of horticultural plants have been added to the herbarium during the year. The need for such material is felt to be constantly increasing.

The larger series of plants which have been acquired during the year are here assembled:

New Accessions.—Paul Allen, 113 plants of Costa Rica; Edgar Anderson, 330 plants of central United States and of horticulture; F. A. Barkley, 1217 plants of Montana and Idaho; Botanic Garden, University of Jagellonica, 208 plants of Poland; Botanical Museum, Harvard University, by L. O. Williams, 436 orchids, mostly from Mexico, the Philippine Islands, and China; Botanical Museum, University of Helsingfors, 200 lichens of Finland; Mrs. H. P. Bracelin, 392 plants of South America, collected by Mrs. Ynes Mexia; Brigham Young University, 43 plants of Utah; California Academy of Sciences, 50 plants chiefly from the Pacific Coast states; Albert Chandler, 124 plants from central and eastern United States; M. A. Chrysler, 51 ferns of Jamaica; Honorable Joseph R. Churchill estate, 500 plants of North America; Ira W. Clokey, 39 plants of Utah; Cornell University, 104 plants of New York; D. S. Correll, 68 orchids of southeastern United States; Arthur Cronquist, 500 plants of Idaho; Hugh C. Cutler, 611 plants from southwestern and western United States; Otto Degener, 451 plants of Hawaii, Philippine Islands, and Borneo; Division of Botany and Plant Pathology, Central Experiment Station, Ottawa, 48 plants of Canada; C. F. Erichsen, 100 lichens of Germany; Field Museum of Natural History, 1720 plants of Missouri and Central America; F. R. Fosberg, 500 plants of Arizona, California, Mexico, and Hawaii; A. O. Garrett, 51 plants of Utah; Howard Scott Gentry, 352 plants of Lower California; T. H. Goodspeed, 61 plants of South America; Gray Herbarium of Har-

vard University, 100 plants of the United States; J. M. Greenman, 36 plants of Wisconsin and Missouri, and 30 photographs of type specimens; H. Hapeman, 102 plants chiefly from South Dakota and Nebraska; Bertrand F. Harrison, 133 plants of Utah; A. A. Heller, 350 plants of California; F. J. Hermann, 51 plants of Michigan; L. R. Hesler, 125 fungi chiefly from Tennessee; George B. Hinton, 500 plants from Mexico; Harry Hoogstraal, 101 plants of Mexico; Leslie Hubricht, 726 plants mostly from central and southeastern United States; Herbarium of Miguel Lillo Institute, 22 plants of Argentina; H. Harold Hume, 33 specimens of *Zephyranthus* from Florida and from horticulture; Iowa State College, 234 plants of Iowa; Maxine Larisey, 40 specimens of *Baptisia* chiefly from southeastern United States; Ethel H. Looff, 55 plants from Alaska; Los Angeles Museum of History, Science, and Art, 383 plants of California and New Mexico; A. H. Magnusen, 50 lichens of Scandinavia; Marshall College by F. A. Gilbert, 100 plants of West Virginia; Montana State University, 495 plants of Montana; Narodin Museum, Prague, 48 fungi from Czechoslovakia; Natural History Museum, Stockholm, 277 plants of Europe; New York Botanical Garden, 1011 plants of tropical America and 30 photographs of types and authentic specimens; Marion Ownbey, 1107 plants of western United States and of horticulture; William F. Palsson, 100 lichens of Iceland; Edith A. Purer, 184 plants of Alaska, Yukon Territory, Washington, Oregon, and California; Rocky Mountain Herbarium, 208 plants of southwestern United States and Canada; Royal Botanic Gardens, Kew, England, 50 plants of Siam; R. J. Seibert, 65 plants of Illinois and of horticulture; Alexander F. Skutch, 638 plants of Costa Rica and Ecuador; A. C. Smith, 91 plants of Venezuela and British Guiana; F. Solis Rojas, 351 plants of Costa Rica; Fräulein Johanna Stephani, 750 tracings from F. Stephani's "Icones hepaticarum"; James R. Stokes, 49 ferns from Georgia; H. Sydow, 300 fungi from various countries; Mrs. R. A. Terry, 362 plants of Panama; United States National Museum, 160 plants of Virginia and South America; University of California, 321 plants chiefly from California; University of Iowa, 63 plants from Iowa and the American tropics; University of Michigan by C. L. Lundell, 38 plants from Mexico and Central America; Uni-

versity of Oklahoma by Milton Hopkins, 91 plants of Oklahoma; University of Wisconsin by N. C. Fassett, 135 plants chiefly plants of Wisconsin; Fr. Verdoorn, 50 mosses from various countries; R. E. Woodson, Jr., 1935 plants from southern United States and Panama; T. G. Yuncker, 685 plants of Honduras.

Many smaller collections have been received and recorded in current numbers of the Garden BULLETIN.

Mounting and Insertion of Specimens.—The mounting and insertion of specimens have continued throughout the year. Miss Elizabeth Ammerman and Mr. A. R. Gordon, graduate students in the Shaw School of Botany, Washington University, were employed by the Garden during the summer months, as extra mounters; and some assistance has been obtained through employment of NYA undergraduate students. Mrs. Edward C. Berry and Mr. D. Flint have also assisted in mounting and distributing lichens and fungi. This extra service has greatly expedited the routine work of preparing specimens for reference and study; but there still remains a relatively large number of unmounted specimens to be sorted, mounted, and placed in the organized herbarium.

The interpolation in the general collection of new material has been greatly handicapped during the latter half of the year, because of the crowded condition of many parts of the herbarium. To alleviate this congestion, arrangements were made for the installation of additional cases; and an order was placed for them early in August. The delivery of the new cases, however, was delayed until late December; but the new cases are now in place and will be ready for use within a short time. The rearrangement of the herbarium will necessitate a shift of about two-thirds of the entire collection. It is estimated, however, that the present addition of new cases will eliminate the existing congestion, and at the same time will furnish the necessary case-capacity for a normal growth of the herbarium for five or six years.

Exchanges.—During the year there were received from scientific institutions and individuals with whom the Garden maintains exchanges approximately 8000 specimens. In the same period about 4000 duplicate herbarium specimens have been distributed to correspondents. These numbers are somewhat lower than they would be under normal international conditions. Because of the

disturbed situation in Europe, few shipments of herbarium specimens have been received from European countries since the first of September of the past year; and only a small amount of duplicate herbarium material has been sent abroad. Several rather large series of duplicate specimens are being withheld because of present delays and uncertainties in transportation.

Field Work.—Considerable field work has been carried on during the year by members of the staff and by graduate students. Noteworthy among these are the collections made in western United States by Mr. and Mrs. Marion Ownbey; in central and southeastern United States by Leslie Hubricht; in central United States by E. Anderson; in the southern states by R. E. Woodson, Jr. and R. W. Schery; and in Central America by Paul Allen. Many former graduates and several of the present graduate students of the Shaw School of Botany have continued to contribute collections of plants made in different parts of the country; these have often formed the basis for new and important scientific records.

Use of the Herbarium.—The herbarium continues to perform an increasing service to the community, as well as to those whose interests are more professional. Many botanists, as in previous years, have consulted the herbarium, some for extended periods of time. The number of specimens loaned to scientific institutions for study by graduate students pursuing research in taxonomy and to specialists for monographic study is much larger than in any one previous year. In fact it has been extremely difficult to meet promptly the numerous and legitimate requests for loans of material.

Groups of Plants Under Special Study.—The particular groups of plants which have been under intensive taxonomic study during the year are the following: Compositae, particularly *Palafoxia, Polypteris,* and *Othake,* by Elizabeth Ammerman; Gramineae, particularly the genus *Poa,* by William L. Brown; *Bumelia,* by Robert B. Clark; *Ephedra,* by Hugh C. Cutler; Hepaticae, by George T. Johnson; *Baptisia* and *Thermopsis,* by Maxine Larisey; *Calochortus,* by Marion Ownbey; Bignoniaceae, especially *Tabebuia* and *Jacaranda,* by R. J. Seibert.

Statistical Summary (for the year ending December 31, 1939).

Number of specimens received during 1939:

By purchase	6,217	
By gift	3,432	
By exchange	7,834	
By transfer	109	
By field work	3,169	
Total	20,761	
Number of specimens mounted and incorporated in 1939, including 9,246 from previously acquired accessions		30,491
Number of specimens carried forward from 1938, less 9,246		1,273,386
Total		1,303,877
Number of specimens discarded in 1939	8	
Number of duplicates withdrawn in 1939	22	
Total	30	
Total number of specimens in herbarium		1,303,847

LIBRARY AND PUBLICATIONS

Due to economy and conditions in Europe, the year 1939 has seen no abnormal growth in the Garden library. The most important serial publications have been continued to be subscribed to, and some books have been ordered from catalogues but nothing particularly outstanding. However, advantage has been taken of this lull to finish a lot of accumulated work. Chief among these was the shifting of the thousands of books and pamphlets now housed in the basement. A good start has been made, but as the work can only be done when nothing else is urgent it will not be finished before the end of 1940. During the course of the shifting, every book is cleaned and checked. If it can be dispensed with, it is removed, and the cards taken out of the file. By discarding such useless material enough space will be made available for expansion for another several years.

Another accomplishment during the year has been cataloguing the several years' collection of seed and nursery catalogues. The Garden has the most complete and valuable file of such publications in the Middle West, but as they are not often used they had been allowed to accumulate until more pressing work was out of the way. Last spring, through the kindness of Mrs. Nellie Bauer, they were all catalogued, and are now on the shelf. Mrs. Bauer is a citizen of St. Louis and a graduate of the

University of Missouri, who gave her services to the Garden in response to the "Friends of the Garden" campaign.

During the summer the library cooperated with the W.P.A. in its Missouri Imprints Inventory, a project to record every book printed in America from 1639 to 1876. The number of such publications found here was beyond expectation, and during December two cataloguers were sent from the branch office to check up. The library will receive a carbon copy of the report when it is completed.

Accessions.—No unusual collections were acquired during the year, but a number of serials, foreign doctoral dissertations and floras, etc., unimportant individually but helping to complete collections, were ordered from catalogues. The following are some of the more interesting acquisitions: American journal of science and arts. Ser. II, vols. 16–17. 1853–1854; Darrah, W. C. Principles of paleobotany. 1938; Fassett, N. C. The leguminous plants of Wisconsin. 1939; Fenneman, N. M. Physiography of eastern United States. 1938; Leighton, W. A. The lichen flora of Great Britain, Ireland, and Channel Islands. 2nd ed. 1872; Leopoldina, vols. 52–58. 1916–23; Lynge, B. Index specierum et varietatum lichenum. 2 vols. 1915–22; Merrill, E. D. and E. H. Walker. A bibliography of eastern Asiatic botany. 1938; Miller, P. Gardeners' Dictionary, 3 vols., 4th abridged ed. 1754; Niwa, T. Chrysanthemums of Japan. 1937; St. Gallische Naturwissenschaftliche Gesellschaft, Bericht über die Thätigkeit, 12 vols. 1878–1890; Societé des sciences naturelles de Neuchâtel, Bulletin, vols. 10–14, 16–18. 1876–1889; Turner, R. Botanologia: British physician or the nature and virtues of English plants. 2nd ed. 1687; Veendorp, H. and L. G. M. Baas Becking. Hortus academicus Lugduno-Batavus. 1938; Willdenow, C. L. Florae Berolinensis Prodromus. 1787. A complete set of Walcott's North American Wild Flowers (5 volumes) was presented by Mr. and Mrs. R. McKittrick Jones.

Several sets of serial publications have been sent to the library of the department of biology at Washington University on an indefinite loan. Among these are "Biochemische Zeitschrift," "Chemical Abstracts," "Biochemical Journal," and "American Chemical Society Journal." The University has agreed to bind

them in the standard binding for Garden books and to keep their identity separate. None of these is now being used at the Garden, but they will be of great benefit in the department of zoology. Furthermore, there is room for them in the biology library, while the Garden space is extremely limited.

Garden Publications.—Volume XXVI of the quarterly ANNALS OF THE MISSOURI BOTANICAL GARDEN was issued during the year, the volume containing 433 pages and 28 plates. One of the papers in this volume was Dr. E. S. Reynolds' "Tree Temperatures and Thermostasy," the results of several years' research work on the subject. The 1939 volume of the BULLETIN (Vol. XXVII), issued monthly except July and August, contains 222 pages and 42 plates. Some of the important BULLETINS were the February number on "Roses," and the October number on "Chrysanthemums," both by Paul A. Kohl, and profusely illustrated with photographs and drawings.

Work has been started on a "Spring Flora of Missouri" by Dr. Julian A. Steyermark, to be published by the Garden, with the Field Museum of Natural History at Chicago furnishing the plates. The book will comprise about 500 pages, 164 plates, and over 400 text-figures and will describe every known plant blooming in Missouri before June 1. From all accounts such a work has been long needed by nature-lovers, scouts, amateur botanists, etc., and it is fortunate to have it undertaken by Dr. Steyermark, who is more familiar with the Missouri flora than any one in the state or elsewhere. Every plant, in addition to being taken up in the keys, will be briefly described and usually it will be illustrated. Emphasis will be placed on the common name, although the botanical name will also be given; and an effort will be made to make the descriptions so simple and untechnical that any one, with the help of the illustrations, will be able to identify even the most uncommon spring plants. The book will be sold at about cost.

Two hundred and sixty-two persons and institutions subscribe to the BULLETIN and 128 send publications in exchange. There are 83 subscriptions to the ANNALS and 428 foreign and 126 domestic exchanges. The Bureau of International Exchanges of the Smithsonian Institution has not yet let it be known what exchanges will be discontinued.

Use of the Library.—In addition to the staff and students in the Henry Shaw School of Botany, the following out-of-town botanists have consulted the library during the year: Dr. Ernst Abbe, Assistant Professor of Botany, University of Minnesota, Minneapolis; Dr. Esther Adams, Teacher of Biological Sciences, Moberly Junior College, Moberly, Mo.; Dr. W. A. Anderson, Associate Professor of Botany, University of Iowa, Iowa City; Dr. F. A. Barkley, Instructor in Botany, University of Montana, Missoula; Mr. J. M. Batchelor, of the U. S. Soil Conservation Service, Washington, D. C.; Dr. Earl E. Berkley, Associate Cotton Technologist, U. S. Department of Agriculture, Washington, D. C.; Mr. James Bible, Superintendent of City Parks, Denver, Colo.; Dr. C. A. Brown, Associate Professor of Botany, University of Louisiana, Baton Rouge; Dr. J. T. Buchholz, Professor of Botany, University of Illinois, Urbana; Dr. E. A. Cockefair, Professor of Botany, Central Missouri Teachers College, Warrensburg; Dr. Hugh C. Cutler, botanical explorer in the Southwest; Dr. W. B. Drew, Assistant Professor of Botany, University of Missouri, Columbia; Dr. Carl C. Epling, Associate Professor of Botany, University of California, Los Angeles; Dr. Walter S. Flory, Horticulturist, Texas Agricultural and Mechanical College, College Station; Mr. M. Truman Fossum, student in horticulture, Cornell University, Ithaca, N. Y.; Miss Susann Fry, graduate student, Washington State College, Pullman; Dr. Harry J. Fuller, Assistant Professor of Botany, University of Illinois, Urbana; Dr. Hereford Garland, Instructor in Forestry, University of Arkansas, Fayetteville; Miss Mary Gentry, graduate student, University of Wyoming, Laramie; Mr. Richard Gnade, graduate student, Harvard University, Cambridge, Mass.; Mr. Neil E. Gordon, Central College, Fayette, Mo.; Mr. H. T. Hartmann, graduate student, Department of Horticulture, University of Missouri, Columbia; Mr. L. H. Harvey, graduate student, University of Michigan, Ann Arbor; Dr. Albert W. Herre, Curator of Ichthyology, Natural History Museum, Stanford University, Calif.; Mr. W. E. Hopper, graduate student in botany, University of Illinois, Urbana; Dr. L. O. Jimenez, of the Academia Costarriquena, San Jose, Costa Rica; Dr. George Neville Jones, Instructor in Botany, University of Illinois, Urbana; Mr. F. L. Kellogg, of the Central States Forest Experi-

ment Station, Columbus, Ohio; Dr. E. P. Killip, Assistant Curator, U. S. National Museum, Washington, D. C.; Dr. Maxine Larisey, Instructor in Botany, Wellesley College, Wellesley, Mass.; Dr. E. J. Little, Jr., of the U. S. Forest Service, Tucson, Ariz.; Mr. Thomas M. Little, Geneticist to the W. Atlee Burpee Seed Co., Lompoc, Calif.; Dr. Juan E. Mackinnon, Assistant at the Instituto de Higiene Experimental Seccion Parasitologia, Montevideo, Uruguay; Dr. Paul C. Mangelsdorf, Assistant Director of Texas Agricultural Experiment Station, College Station; Dr. J. Francis Macbride, Assistant Curator, Field Museum of Natural History, Chicago; Mr. J. Myrlin McGuire, research assistant, University of Iowa, Iowa City; Mr. J. T. Middleton, Graduate Assistant in Botany, University of Missouri, Columbia; Dr. C. E. Moore, Head Biology Department, State Teachers' College, Memphis, Tenn.; Mr. H. E. Morris, botanist and bacteriologist, Montana State College, Bozeman; Mr. M. J. Reed, graduate student, University of Notre Dame, Notre Dame, Ind.; Prof. Alfred Rehder, Curator of the Herbarium, Arnold Arboretum of Harvard University, Jamaica Plain, Mass.; Dr. Philip K. Reynolds, in charge of Banana Dietetic Research, United Fruit Co., New York City; Mr. F. F. Rockwell, Garden Editor of New York *Times;* Mr. Art Smith, Horticulturist, Boone, Ia.; Mr. Julian F. Smith, Central College, Fayette, Mo.; Mr. H. A. Stevenson, of the U. S. Soil Conservation Service, Elsberry, Mo.; Cora Shoop Steyermark, Chicago; Dr. J. A. Steyermark, Assistant Curator of the Herbarium, Field Museum of Natural History, Chicago; Dr. Delbert Swartz, Associate Professor of Botany, University of Arkansas, Fayetteville; Mrs. J. J. Taubenhaus, in charge of the Herbarium, Texas Agricultural Experiment Station, College Station; Dr. F. A. Varrelman, Professor of Botany, DePaul University, Chicago; Mr. E. Walther, member California Academy of Science and Assistant Superintendent of Golden Gate Park, San Francisco; Dr. Selden R. Warner, Professor of Botany, Sam Houston Teachers College, Huntsville, Texas; Mr. Stephen White, graduate student, University of Michigan, Ann Arbor, Dr. F. L. Wynd, Assistant Professor of Botany, University of Illinois, Urbana.

Among the groups visiting the library were: a party of superintendents of Texas public schools, Mr. C. M. Selman, of Bren-

ham, Mr. W. C. Perkins, of Shamrock, and Mr. Allen Kavanaugh, of Wheeler County; students from the University of Illinois Library School, Urbana, accompanied by Dr. Errett W. McDiarmid; botany students from Junior College of Moberly, Mo., accompanied by Dr. Esther Adams; classes in plant taxonomy and horticulture, University of Missouri, Columbia, under the leadership of Prof. H. W. Rickett and Prof. T. J. Talbert respectively; economic botany class, University of Illinois, Urbana, accompanied by Dr. Harry J. Fuller; Senior High School of Wood River, Ill., under the leadership of Mr. W. E. Hopper; Dr. L. A. Kenoyer, chairman of the biology department, and Mr. Frank Hinds, instructor, Western State Teachers College, Kalamazoo, Mich., with a group of their students.

The library also loans books on the interlibrary-loan plan, 181 such loans having been made to 38 institutions during the year.

Statistical Information.—

There have been donated to the library or received in exchange during the year 538 books valued at $1,328.68, 2,638 pamphlets valued at $384.67 and five manuscripts valued at $5.30. Three hundred and seventy-two books were bought at a cost of $2,457.52 and 27 pamphlets at a cost of $52.08. Ninety-four parts of publications purchased at a cost of $237.85, and previously listed as pamphlets, now compose complete volumes and have been recatalogued under that category. The library now contains 53,730 books and 84,029 pamphlets. There are 349 manuscripts valued at $1,709.70 and 1,062,444 index cards valued at $13,385.03. A total of 10,407 cards were added during the year, of which 1,030 were written by Garden employees, and 9,377 were purchased at a cost of $222.74. Two hundred and thirty-eight books were bound.

ANNUAL BEQUESTS

The annual flower sermon "On the wisdom and goodness of God as shown in the growth of flowers, fruits, and other products of the vegetable kingdom," provided for in the will of Henry Shaw, was preached at Christ Church Cathedral, on April 30, by Dr. Angus Dun, of the Episcopal Theological School, Cambridge, Massachusetts.

The Gardeners' Banquet Fund was used to provide turkeys for employees at Christmas.

Neither the Trustees' Banquet Fund nor the fund for the provision of prizes at flower shows was drawn upon during 1939.

ATTENDANCE FOR 1939

(Not including visitors to Arboretum)

	Week-days	*Sundays*
January	8,198	4,132
February	11,257	17,969
March	11,501	6,939
April	11,017	16,172
May	22,767	15,407
June	13,812	9,151
July	17,644	11,439
August	24,755	11,293
September	14,167	11,407
October	16,022	15,670
November	24,133	22,540
December	7,354	12,143
	182,627	154,262
		182,627
Total		336,889

GEORGE T. MOORE,
Director.

STATISTICAL INFORMATION FOR DECEMBER, 1939

GARDEN ATTENDANCE:

Total number of visitors 19,497

PLANT ACCESSIONS:

Total number of plants received as gifts 4

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought 11
Total number of books and pamphlets donated 92

HERBARIUM ACCESSIONS:

By Purchase—

Cronquist, Arthur—Plants of Idaho 500
Smith, A. C.—Plants of Venezuela and British Guiana, collected by Albert S. Pinkus 91
Terry, Mrs. R. A.—Plants of Panama 362
Palsson, William F.—Plants of Iceland 100

By Gift—	
Anderson, Edgar—Plants of Tennessee	3
Baxter, R. W. *Spathoglottis* from the Hawaiian Islands	1
Cheesman, C. E.—Plants of Trinidad and Tobago	11
Davis, R. J.—Asclepiadaceae and Apocynaceae from Idaho	12
Featherly, H. I.—*Forestiera acuminata* (Michx.) Poiret from Oklahoma	1
Museo Rocha, Ceara, Brazil—Lichens of Brazil	11
Schultes, R. E.—Plants of Mexico	4
Seibert, R. J.—Plants of Illinois and of horticulture	24
Smith, A. C.—Plants of South America	2
U. S. Dept. of Agriculture, Bureau of Plant Industry, Plant Introduction Garden *Tanaecium crucigerum* (L.) Seem. from horticulture	2
U. S. Nat. Museum, by E. P. Killip—Plants of Venezuela	6
University of Kentucky, by Frank F. McFarland—Plants of Kentucky	8
University of Michigan, by C. L. Lundell—Plants of Mexico	7
By Exchange—	
Iowa State College, by Ada Hayden—Plants of Iowa	234
U. S. Nat. Museum by E. P. Killip—Plants of South America	59
Total	1,438

STAFF
OF THE MISSOURI BOTANICAL GARDEN

THE GARDEN, 2315 TOWER GROVE AVENUE, ST. LOUIS, MISSOURI

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MISSOURI BOTANICAL GARDEN BULLETIN

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SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date to the death of Mr. Shaw, in 1889, the Garden was maintained under the personal direction of its founder, and while virtually a private garden it was, except at certain stated times, always open to the public. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was designated by Mr. Shaw as its official title and in his will and all of his writings he specifically referred to it as the "Missouri Botanical Garden." By a provision of Mr. Shaw's will the Garden passed at his death into the hands of a Board of Trustees. The original members of the Board were designated in the will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will, the immediate direction of the Garden is vested in a Director, appointed by the Board of Trustees. The Garden receives no income from city or state, but is supported entirely from funds left by the founder.

The city Garden comprises 75 acres, where about 12,000 species of plants are growing. There is now in process of development a tract of land of over 1,600 acres outside the city limits which is to be devoted to (1) the propagation and growing of plants, trees, and shrubs, designed for showing either indoors or outside, at the city Garden, thus avoiding the existing difficulties of growing plants in the city atmosphere; (2) gradually establishing an arboretum as well as holding a certain area as a wild-flower reservation, with the idea that possibly at some future time this may become the new botanical garden.

The Garden is open to the public every day in the year except New Year's Day and Christmas—week days from 8:00 a. m. until sunset; Sundays from 10:00 a. m. until sunset. The greenhouses are closed every day at 5:00 p. m.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Place, on the Sarah car line (No. 42). Transfer south from all intersecting lines.

DRAGON BLOOD TREE IN FLOWER

Missouri Botanical Garden Bulletin

Vol. XXVIII FEBRUARY, 1940 No. 2

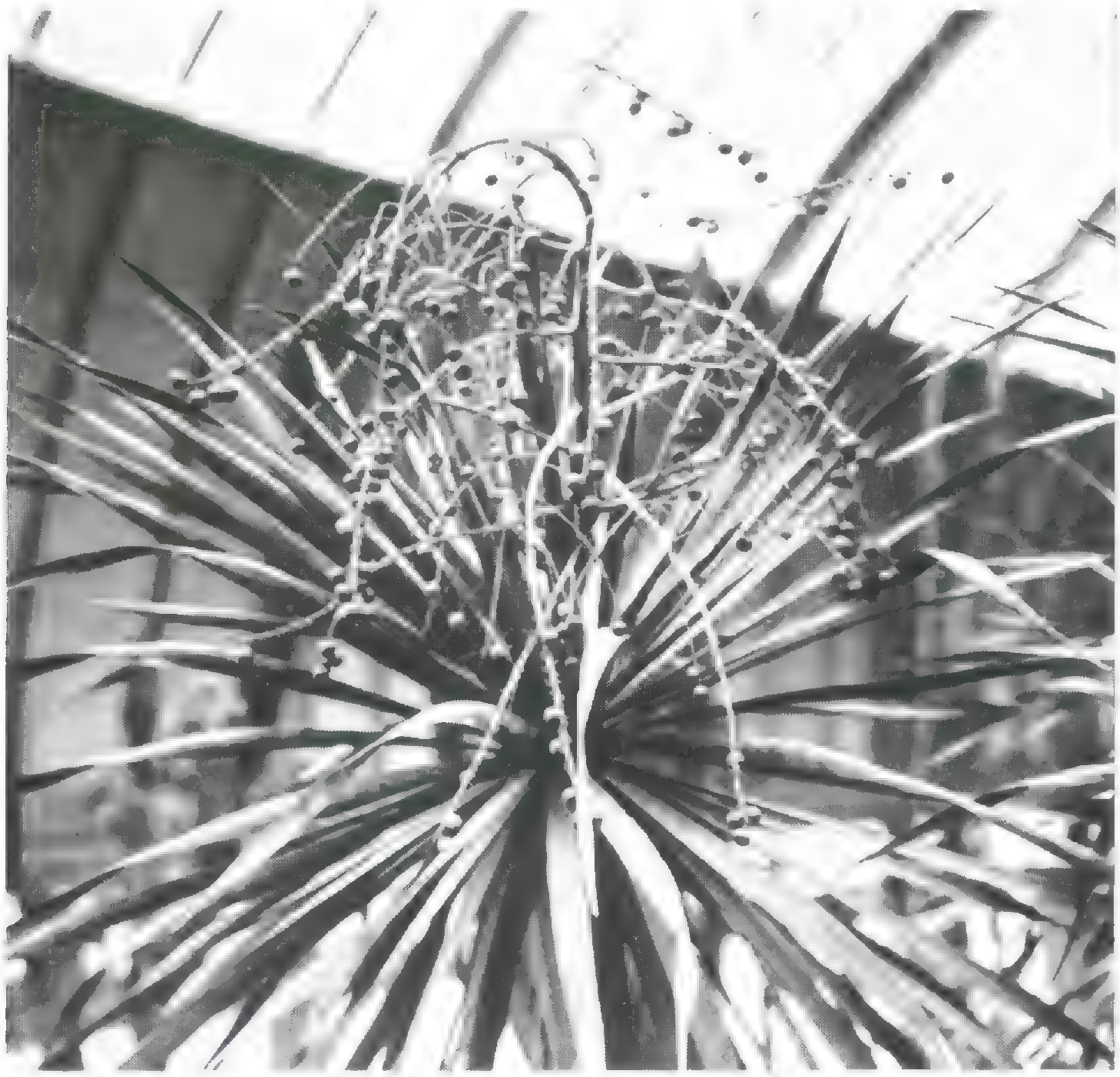
THE DRAGON-BLOOD TREE

Less than seventy-five years ago a hurricane swooped down upon the Canary Islands and destroyed one of the most famous trees of the world. Curiously enough, though, it was not a tree in the strict sense of the word but a kind of Lily, which supposedly had its origin in the dawn of history. According to the naturalists of that day, it was the oldest living plant in the world, much older than the big trees and redwoods of California. In California's Mariposa Grove there stands the venerable "Grizzly Giant," approximately 3,800 years old. In the Sequoia National Park there is another hoary veteran, "General Sherman," which is even older by about two hundred years. Only the giant cypress of Tule, in Mexico, is said to have nearly approached the antiquity of the dragon-blood tree of the Canary Isles. The age of the destroyed Canarian Methuselah was estimated at 6,000 years, yet it was only seventy feet high, a mere Liliputian when compared with the mammoth Sequoias, which are four and five times higher.

The celebrated dragon-blood tree flourished on the isle of Teneriffe, near the town of Orotava, and much of the romance of the Canary Islands was centered about this ancient specimen. When the Spaniards assumed authority of the islands, nearly five centuries ago, they found that rot diseases had taken their toll of the inner pulp of the tree and that the whole trunk was hollow. A chapel for Catholic services was built in the huge cavity by Alonzo del Lugo and his conquistadores. Later a staircase was built in the interior by which the tree could be ascended as far as the forking of the trunk. No one really knows for what length of

time the Guanches, the original inhabitants of the island, had used this "living sanctuary" for their religious ceremonies.

The dragon-blood tree, known botanically as *Dracaena Draco,* is not an uncommon plant in collections. It is said to have been introduced into England prior to 1640, and probably every botanical garden in Europe and America possesses a plant of greater



DRAGON BLOOD TREE IN FRUIT

or less size. Unfortunately, this species rarely flowers outside of tropical and subtropical regions; therefore it is worth recording here the specimen which condescended to bloom for the first time last summer in the cactus house of the Missouri Botanical Garden.

The plant in question is the gift of the late D. S. Brown, a philanthropic St. Louisan who possessed the finest and most extensive private collection of tropical plants in the Midwest. It

came to the Garden in 1918 and at present is thirteen feet tall, three outstretched branches arising from the trunk. Evidently the dragon-blood must have flowered in the Brown greenhouse for it is known that branching does not occur until after the tree blossoms; and since it generally does not flower until the fifteenth or thirtieth year, our plant must be at least forty or fifty years old.

The trunk of our dragon-blood branches in octopus fashion at five feet. The branches are scarred by the transverse lines of the fallen leaves and bulge at unequal intervals, greatly remindful of a snake that has swallowed several small live animals. The trunk is conspicuously fissured by the scale-like splitting of the bark, a natural condition of the plant. Each branch is four to five feet long and is crowned by a tuft of about 135 leaves. The leaves attain a length of three feet, are quite glaucous, coriaceous, narrowly sword-shaped, and sheathing at the base. From the center of the crown of leaves arises the flower stalk, on which the clusters of five or six minute flowers are arranged in a panicle. Several thousand flowers were produced but only a small proportion have materialized into fruits. The fruit is a globular olive-green berry, turning an orange color at maturity. It may be of interest to record that the fruit sprouts from a three-celled ovary, yet very rarely do the three ova develop into seed. Generally a single tannish pearl-like seed is contained in a berry but two are not uncommon. The French missionary nuns in Portugal used the seeds for rosaries when they took up their residence at the asylum of Ajuda, where a large dragon-blood flourished.

The dragon-blood tree receives its mystifying name from the fact that at certain times a blood-colored resinous substance exudes from cracks in the trunk. This "dry-blood" can be plainly discerned on the Garden specimen. The resin has been found in the sepulchral caves of the Canary Islands and has hence been supposed to have been used by the aborigines in embalming their dead. At one time the resin formed a considerable article of commerce, being highly esteemed in medicine and in the preparation of varnish. The commercial dragon's blood of the present day is not obtained from *Dracaena Draco* but mostly from several species of palm.

The dragon-blood is a fit subject for the indoor gardener, grow-

ing very readily from seed. It takes its place with sansevierias, aspidistras, various bromeliads, and other ornamental house plants that can withstand a lot of abuse. The young plants are very similar in appearance to those of the graceful *Yucca gloriosa*. A year-old seedling will produce a tuft of approximately thirty-five leaves, eight to twelve inches in length. L. C.

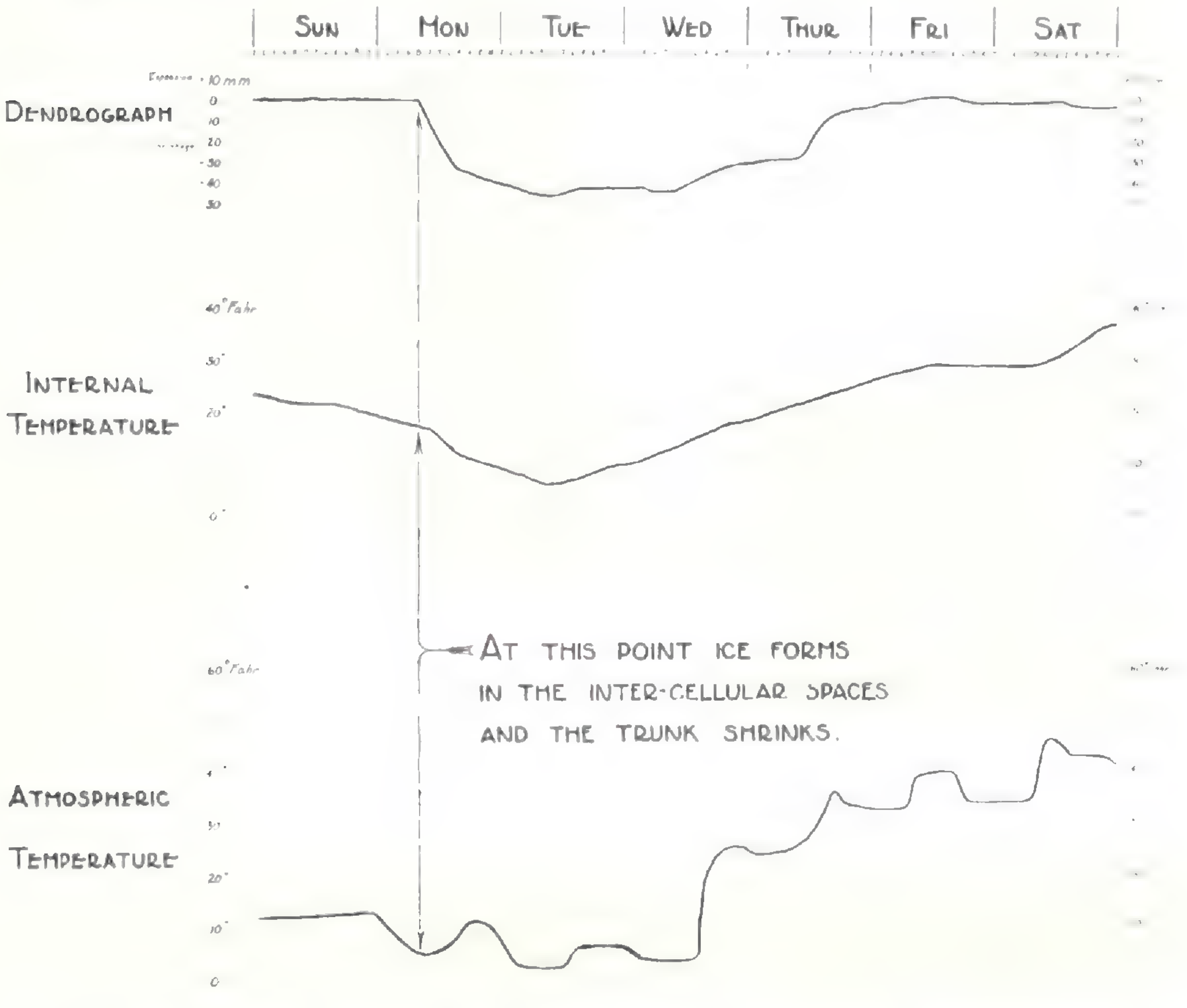
FROST CRACKS

A very cold, very wet or very dry season usually provides the gardener with some new problem. To cope with the "unusual dry weather" he must begin to irrigate and perhaps to mulch. In abnormally wet times he must either devise some drainage system or change his plantings. Extremely cold winters usher in other problems. Just what the cold of January, 1940, will reveal cannot be determined at this date. So far as shade trees are concerned we need not expect many new difficulties. The occurrence of "frost cracks," however, has caused some comment and not a few calls for information.

Frost cracks are those longitudinal splits which appear in tree trunks during cold weather. They are seldom seen at their worst since few gardeners have the inclination to inspect trees during sub-zero periods, and the cracks partly close when the weather moderates. Native trees are seldom injured by the cold of winter; yet a list of the trees likely to be damaged would include most of the oaks in this vicinity. The willow oak (*Quercus Phellos* L.) of the South—of which there are several specimens in the Garden—is very liable to this injury. The tulip tree (*Liriodendron tulipifera* L.) commonly cracks during periods of low temperature, as does the horse chestnut (*Aesculus Hippocastanum* L. and its ornamental hybrids). Even the American elm (*Ulmus americana* L.) and the cypress (*Taxodium distchum*) may be fractured in some seasons.

Frost cracks may open wide enough to permit the insertion of most of a hand. When this happens we have a practical demonstration of the forces involved. During sub-zero weather the actual contraction of the tree trunk may be measured with a common

tape line. An explanation of the shrinkage phenomenon seems to center upon the stresses set up when ice crystals form. The center of a tree may remain quite warm until the beginning of a cold wave. With the rapidly dropping temperature the outside begins to cool first and finally to freeze while the very center remains much warmer. As ice forms in the intercellular spaces water is withdrawn and the wood undergoes a rapid drying out. The weather checks we see in a piece of lumber exposed to the sun are very much like frost cracks, except for size. Both are caused by dehydration.



Frost cracks then are the direct result of extreme cold and the rapid translocation of water which follows freezing. The accompanying diagram shows the behavior of a bur oak (*Quercus macrocarpa* Michx.) during zero weather in February, 1934.

The dendrograph line indicates the expansion or contraction of the trunk; for comparison, the air temperature and the internal-trunk temperature are also included. The chart shows that a tree trunk begins to freeze at about 19° Fahr., and at which point the dendrograph records an abrupt contraction of the outer layers of wood. The slow cooling of a tree trunk can be seen in the internal-temperature curve; in fact, eight hours may elapse before the internal temperature begins to approach that of the air. Therefore, the outer layer—perhaps four or five inches thick—is freezing and shrinking around a warmer core, which is compressible only within certain limits. This sets up a tremendous tension and the outer portion suddenly fractures with the boom of a shot gun. The split always follows the grain and, of course, releases the strain.

With milder weather the wood thaws and reabsorbs the proper amount of water. The crack then nearly closes and no permanent harm is apparent. This would be the end of the matter except that the corky bark—which is an armor—has been ruptured and can no longer offer complete protection to the underlying wood. Healthy trees always attempt to heal over such wounds, just as they do pruning cuts, but the succeeding winters usually re-open them. The healing processes are repeated annually and just as regularly come to naught. Often the wound tissue of six or more such attempts can be counted.

The importance of the bark is well known and we indicate our acceptance of this fact when we apply pruning paints. Frost cracks may be considered as very large and deep pruning wounds which do not dry out in summer. Thus they offer even better opportunities for the entrance of those enemies of woody plants—insects and wood-destroying fungi.

Frost cracks should be watched, and if healing is slow or disease enters, the tree surgeon should be consulted. Some degree of protection can be obtained by the installation of a filling as is done with ordinary cavities, but usually such work requires more judgment and experience than is needed in simple trunk cavities.

A. P. B.

IDENTIFICATION AND CONTROL OF COMMON PLANT PESTS

PLANT PEST NO. 2—MEALY-BUGS

Second place on our present insect "hit parade" goes to mealy-bugs by a wide margin. In fact they become so pestiferous at times that aphids have to keep busy twenty-four hours a day pumping out plant sap to even "win by a nose."

Mealy-bugs are closely related to the scale insects and may be found on house plants at any time of the year. They are brownish to light orange in color and entirely covered with a dense white, waxy, mealy material which takes the form of short projecting filaments along the lateral margins of the body. This waxy covering protects the bugs from certain insecticides which are used to control them. The mature female mealy-bugs are small, sluggish, soft-bodied insects about one-fourth inch in length and broadly oval in shape. They may occur singly or in clusters anywhere on the host plant, but mostly they prefer the tender growing tips, the under-sides of the leaves and protected areas where they can feed and multiply unmolested. The males are small, delicate, two-winged flies of the retiring type that do not feed in the adult stage and die soon after mating. So, as might be expected, it is the female of the species that causes all the trouble. They have sucking mouth parts like aphids and rapidly devitalize the host plants by extracting the cell sap. Infested leaves become deformed, turn yellow and drop prematurely. Flowers are sometimes deformed by mealy-bugs feeding just below the buds. Unless checked these pests soon swarm all over the plant and eventually kill it. In addition they secrete a sweet sticky honey-dew which encourages sooty fungus and ants.

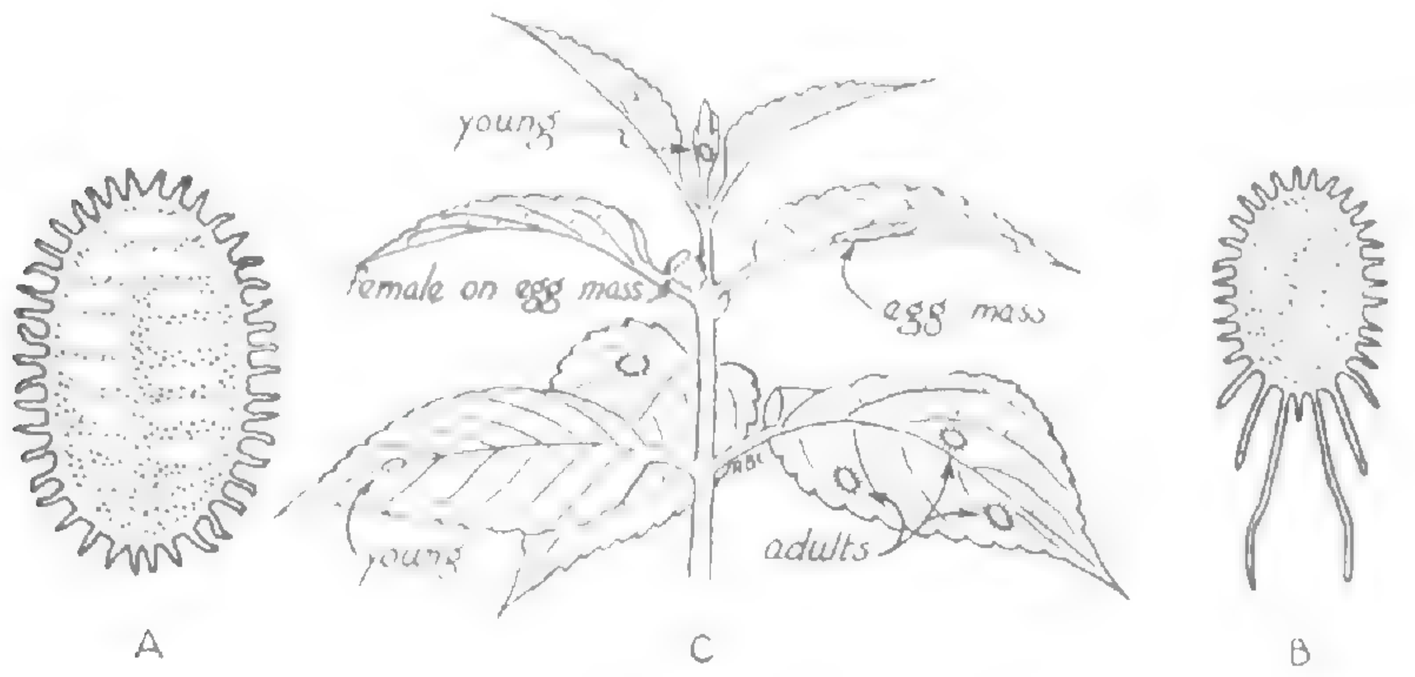
There are several kinds of mealy-bugs but only three are of importance to the indoor gardener:

1. Common mealy-bug
2. Long-tailed mealy-bug
3. Mexican mealy-bug.

The common mealy-bug is the one that causes most of the damage to house plants. It attacks nearly all kinds of vegetation but prefers soft-stemmed specimens such as coleus, geranium, croton,

cyperus, ivy, orchid, African violet, cactus, begonia, poinsettia, fuchsia, fern, gardenia and oleander. The females are active up to the time that they are ready to deposit eggs. Then they select a favorable spot on the plant, become more or less stationary and build up a colony of 300 to 600 yellowish eggs which is covered with a loose, white, cottony secretion. These eggs hatch in about ten days and the youngsters, which resemble the adult female, soon spread over the entire plant and immediately get to work pumping out cell sap. They grow rapidly and a new generation appears about once a month.

The long-tailed mealy-bug is easily identified by its long tail filaments. This type is a tropical or semi-tropical species found



A, common mealy-bug, greatly enlarged; B, long-tailed mealy bug, greatly enlarged; C, typical mealy-bug infestation on coleus.

mostly in greenhouses. It is not as destructive as the common mealy-bug because the family increase is not so rapid, the females giving birth to living young instead of laying countless eggs. Long-tailed mealy-bugs seem to be particularly happy on ferns, but in a pinch there is no doubt that they will gladly feast on numerous other plants.

The Mexican mealy-bug is of fairly recent introduction and occurs mostly in the South. It resembles the common type and has been reported destructive on chrysanthemums, cotton, and citrus fruits. In time it may become a pest of major importance.

Control measures.—Mealy-bugs are more easily prevented than cured. A thriving infestation is often hard to eradicate without

damaging the host plant. The safest and most economical means of control is to wash off the bugs and egg clusters with a forceful spray of water. This treatment works remarkably well in the majority of cases. Plants which are too fragile to stand strong syringing with water may be dipped in a strong soap solution to which 40 per cent nicotine sulphate (1 teaspoonful to a quarter of water) has been added. Spraying the mealy-bugs with a solution of Black Leaf 40 and Volck (½ teaspoonful of each to a quart of water) has proved effective. Plants that may be injured by such potent sprays should be thoroughly washed with water about two hours after the spray is applied. Sponging and brushing infested plants with soapy water can be used to advantage in certain cases. Sprays containing kerosene should be avoided as they may injure the plant. Anointing the bugs with a drop of alcohol is another method of control frequently heard about. This is not only a tedious and uncertain process but also a downright waste of good antifreeze.

In the March issue of the Garden BULLETIN we will consider Plant Pest No. 3—Red Spiders. D. C. F.

THE LIBRARY OF HENRY SHAW

The following paper was kindly contributed by Mr. John Francis McDermott, of the department of English of Washington University.

Not the least part of Henry Shaw's contribution to science was the collection of books that he left to the Missouri Botanical Garden. The idea of a library formed to complement his cherished project was apparently suggested to him by Sir William J. Hooker, Director of Kew Gardens, who wrote to him, on 10 August 1857, that "very few appendages to a garden of this kind are of more importance for instruction than a library and economic museum, and these gradually increase like a rolling snowball." Dr. George Engelmann, then in Europe, started that ball rolling the next year by purchasing, on Shaw's order, thirty-four works which Shaw had selected from a list prepared by Engelmann in consultation with European botanists. From this time on Shaw

must have bought such books in quantity, for when he died in 1889 he left a very considerable library.[1]

At that time (as we can discover from the record of his estate in the files of the Probate Court) in the library of the Museum building there were "83 volumes of Engelmann's Edition" which were appraised at $13 each, reaching a total of $1,079. There were also "1077 volumes of Botanical Works" by the following authors: John Abbott [?]; W. Aiton; J. Fiske Allen; J. H. Balfour; P. Barry; Wm. P. C. Barton; S. O. Beeton; Elisabeth Blackwell; A. Bonpland and Alex. de Humboldt; Joseph Breck; Robert Brown; Robert Buist; Boissier; Agnes Catlow; T. Caruel; James Henry Coffin; William Curtis; John Darby; Wm. Darlington; Aug. Pyr. de Candolle; Alphonse de Candolle; L. G. Delamarre; [R.] Desfontaines; Dillenius; George Don; P. N. Don; Duhamel; Dumortier; D. C. Eaton; G. B. Emerson; E. Emmons; W. H. Emory; S. Endlicher; G. Engelmann; Ellis; A. Fendler; Flore [?]; C. C. Gmelin; S. G. Gmelin; A. Gouan; Asa Gray; Asa Gray and John Torrey; Gussone; R. K. Greville; J. F. Gronovius; S. Hales; W. H. Harvey; Peter Henderson; J. S. Henslow; J. Hull; J. D. Hooker; W. J. Hooker; J. Hoopes; Franklin B. Hough; C. M. Hovey; G. Hughes; Alex. de Humboldt, A. Bonpland and C. S. Kunth; H. N. Humphreys; C. Jacquin; N. J. Jacquin; J. Kennedy; C. S. Kunth; Lehmann; W. Lempriere; J. Lindley; Ledebour; Linnaea; Linnaeus; C. Linné; Adam Lonicerus; J. C. Loudon; J. Lunan; C. F. P. Martius; J. Martyn, P. A. Matthiolus; C. Milne; T. Moore; H. Muhlenberg; Michaux; Michaux and Nuttall; P. Miller; W. Neubert; N. J. de Necker; J. S. Newberry; T. Nuttall; Owen; P. S. Pallas; Paxton; C. H. Persoon; A. Philipps [H. Phillips?]; G. Pinney; Poiret; Pursh; Rousseau; Richard; Risso; Rumphius; Sagra;

[1] Biographical information in this article is drawn from "The Library of the Missouri Botanical Garden," MISSOURI BOTANICAL GARDEN BULLETIN (Dec., 1926); and Thomas Dimmock, "Henry Shaw," reprinted from the FIRST ANNUAL REPORT OF THE MISSOURI BOTANICAL GARDEN, 1890. The specific detail concerning Shaw's library in 1889 is from the records of his estate in the Probate Court of Saint Louis (File No. 17,369); information concerning the purchase from the Mullanphy estate, from Probate Court Records, File No. 1074. The various lists given in this article are reproduced as they appear in those papers.

Aug. de Saint-Hilaire; P. A. Schenck; Schleiden; Schoepff; Schott; Seemann; Smith & Abbott; Smithsonian Institution; O. Swartz; Sprengel; Schwemme [?]; Schkuhr; R. Sweet; J. Torrey; Tilli; Tournefort; Van Houtte; Van Heurck; Vilmorin, Andrieux & Cie; Wight; Willdenow; O. R. Willis; Alph. Wood; H. C. Wood; Walpers' Annales; W. Woodville; J. K. Hasskarl.

A number of works were listed by title in this inventory of 2 September 1889; these were mostly periodicals and special reference works: The Botanical Magazine; The British Florist; Dictionnaire des Sciences Naturelles; Flora Atlantica; The Garden; The Gardeners' Chronicle; The Gardener's Monthly; The Horticulturist; [Lunan's] Hortus Jamaicensis; [Aiton's] Hortus Kewensis; Principes de Botanique; Reports of the St. Louis Public Schools; Vegetable Substances; Transactions of the Linnean Society; [St. Hilaire's] Plantes de la France; [Humboldt, Bonpland & Kunth] Nova Genera et Species Plantarum; [Don's] History of Dichlamydeous Plants; Phillip's Voyage to Botany Bay; [Duhamel's] Traite des Arbres et Arbustes; [DeCandolle's?] Succulent Plants; [Coffin's] Winds of the Globe; Patent Office Reports on Agriculture; Diseases of Domestic Cattle; Transactions of the Department of Agriculture of Illinois; Wisconsin Farmer; Popular Field Botany; Fleurs de Pleine Terre; Journal of Agricultural Society; lot of books marked "Executive Documents, etc."; Michigan Horticultural Society; Minnesota State Horticultural Society Annual Reports; [de Candolle's] Regni Vegetabilis Systema Naturale; United States Geological Explorations.

Following this list in the inventory was a reference to "all other books and pamphlets contained in six glass cases in the Library-Room of the Museum, altogether 1077 bound volumes and a lot of unbound pamphlets." This statement probably means that the total quantity includes all items in the Museum library, except possibly one lot of "7 Trunks containing Pamphlets and unbound periodicals valued at $14" that seems to be mentioned only in the appraisement of 10 September. The total value then set on the library was $3,050.00. One other part of the Museum furnishings may be of interest here: pictures (oil portraits) of John Lindley,

Adr. de Jussieu, Thomas Nuttall, George Engelmann, Alexander Wilson, Charles V. Riley, F. André Michaux, Asa Gray, Tournefort, De Candolle, Linnaeus, and Magnol were appraised at $50 each. A portrait of Shaw, done in 1835, was valued at $200.

The authors and publications listed above, with a few exceptions, represent Shaw's interest in botany and his intention to build up a scientific collection as a valuable addition to his garden. They do not show, however, the full extent of his library nor do the records cited show how early his purchases began or what variety they offered. The quantity of his books is illustrated by further reference to the records of his estate. He maintained, besides the Museum building, two residences and apparently wherever one turned in those houses one found books. In the library at the city residence, 7th and Locust Streets, the appraisers located "1 Lot of Books in Book Case" (valued at $50), "224 Books in Book Case" ($100); "1 Lot of Books & Pamphlets in Base of Book Case" ($25). A room on the second floor contained "1 Lot Old Books" valued at $1. At least five rooms in the Tower Grove house contained books. In the front parlor was a "Rosewood Book Case and Books" worth $200, "1 music stand and lot of Books" valued at $25, and "1 Mahogany Desk Book Case and Books" ($50). "1 Large Mahogany Book Case and Books" ($200) stood in the dining room. In the upper hall was another "Lot of Books in Case" ($100). But the principal lot upstairs was housed in "Room No. 3." Here were "1 large Book Case and Books" ($200); "1 Cylinder Book Case and Books" ($50), and "1 Lot of Books on Secretary" ($1).

The indifference of the appraisers deprives us of the possibility of knowing what these numerous bookcases contained. Shaw's biographer, however, tells us that he was "especially fond of French literature and his library is quite rich in the standard authors as well as lighter works"; he had also "well-thumbed grammars and dictionaries, and a good selection of Italian and Spanish books."

This account so far represents the books that Shaw possessed at the time of his death but his interest in books was not simply the diversion of a man retired from business. Early in life he began to build a widely assorted library. The first record of this ac-

tivity comes twenty-five years before the first purchase toward a museum library. When the library of John Mullanphy was sold at auction, 7 December 1833, Shaw bought twenty-two items, amounting to one hundred and twelve volumes, and paid for them $54.09. This purchase included works of history, biography, travel, literature, geography, classics, and other subjects. Since it illustrates so well the varied taste of the man, I give the entire purchase as it appears in the Mullanphy bill of sale—with a warning that the document was not always legible.

No. of Vols.	*Title*		*Price Paid*
1	Hutchinson's Xenophon		$ .95
12	Works of Frederic II	.30	3.60
4	Voyage to Greece	.28	1.12
4	Rotbur's [?] Voyages		.80
4	Letters of du Deffand	.33	1.32
2	Journal of a Lady [?]	.26	.56
1	Latin dictionary		.38
6	Mirror of Pans [?]	.26	1.56
2	Dobson's Petrarch	.50	1.00
1	Cabinet of Momus		.20
4	Manual Croncile [?]		1.00
1	Hallam's Letters [?]	.31	.31
6	Letters of St. Augustine	.18	.72
16	Geographie Universelle of Büsching	.15	2.40
7	History of Malta	.15	1.05
8	Voyage in Italy	.15	1.20
4	Famous proceeding	.28	1.12
12	Works of La Fontaine		0.00
2	Letters of Pope Clement XIV	.20	.40
11	Antigastus of Herculaneum	2.25	24.75
3	Atlases	3.12½	9.38
1	Hall [?] Journey [?]		.31

NOTES

The "Land We Live In," the subject of radio talks given Sunday evenings over Station KMOX, depicted the life of "Henry Shaw," in the program of January 14.

The *New England Gladiolus Society Year Book* for 1940 contains an article by Dr. D. C. Fairburn, Horticulturist to the Garden, entitled "Gladiolus Are Hardy in Missouri."

Mr. Ladislaus Cutak, in charge of Succulents at the Garden, gave a talk before the Missouri State Growers School, at the Hotel Chase, January 31, on "Along the Cactus Trail."

Dr. George T. Moore, Director of the Garden, spoke at the Junior League lecture course, February 12, on "What's New in the Plant World—If Anything."

Dr. David C. Fairburn, Horticulturist to the Garden, spoke at the Monday Club of the St. Louis Horticultural Society, February 6, on "Raising Plants from Seeds."

Dr. Henry N. Andrews, instructor in the Henry Shaw School of Botany, and Mr. Russell J. Seibert, graduate student at the Garden, spent Jan. 27-Feb. 11 collecting plants in Florida.

Mr. George H. Pring, Superintendent of the Garden, spoke before the Optimists' Club, January 19, on "Romance of the Plant World"; and before the Kirkwood Garden Club, January 22, on "Plant Reproduction."

Mr. Paul A. Kohl, Floriculturist to the Garden, was one of the participants in the after-dinner forum discussion on "Smoke and Its Effects on Living Things [Plants]," over Radio Station KXOK, December 12. On January 31 he gave an illustrated talk before the Missouri State Growers School, at the Hotel Chase, on "The Missouri Botanical Garden"; and on February 6 he lectured on "Roses" before the Ladue Garden Club.

Recent horticultural and florists' magazines have reprinted the following BULLETIN articles: "Chrysanthemums," by P. A. Kohl (from the October 1939 BULLETIN), reprinted in the November 15 issue of *Horticulture;* "What Shall We Do With the Christmas Poinsettia?" by P. A. Kohl (December 1938 BULLETIN), in the January 1940 issues of *Flower Grower, Garden Digest,* and *Real Gardening;* "Winter Care of Succulents," by Ladislaus Cutak (December 1939 BULLETIN), in the January issue of *Desert Plant Life;* "African Violets," by D. C. Fairburn (December 1939 BULLETIN), in the January *Real Gardening* and January 19 *Southern Florist.*

Recent visitors to the Garden include the following: Mr. Walter S. Reeves, secretary of the California Fig Growers and Packers,

Fresno; Miss Elizabeth A. Meredith, of the Wm. C. Meredith Co., Wood Preservers, Atlanta, Ga.; Dr. C. Audrey Richards, Pathologist, Forest Products Laboratory, U. S. Dept. Agr., Madison, Wis.; Dr. Henry Schmitz, Dean of the School of Forestry, University of Minnesota, St. Paul; Dr. Hugh C. Cutler, botanical collector, Santa Fe, N. Mex.; Dr. Louis Wheeler, instructor in botany, University of Missouri, Columbia; Dr. Harry J. Fuller and Dr. F. Lyle Wynd, Associate Professors of Botany, University of Illinois, Urbana; Mrs. Edward Rodeman, of the Jefferson City Garden Club, Jefferson City, Mo.; Miss Esther Adams, instructor in biological sciences, Junior College, Moberly, Mo., accompanied by her botany students.

STATISTICAL INFORMATION FOR JANUARY, 1940

GARDEN ATTENDANCE:

Total number of visitors 11,054

PLANT ACCESSIONS:

Total number of plants and seed-packets received as gifts 29

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought 32
Total number of books and pamphlets donated 33

HERBARIUM ACCESSIONS:

By Purchase—

Avenue Camera Store—Photographs of type specimens of *Bumelia* 4
Bracelin, Mrs. H. P.—Plants of Mexico and South America, collected by Mrs. Ynes Mexia 558
Harper, R. M.—Plants of Alabama and neighboring states .. 58

By Gift—

Anderson, E.—*Helenium tenuifolium* Nutt. from Arkansas 1
Bock, H. S.—Plants of horticulture 2
Chandler, Albert—Plants of eastern and central United States 42
Clark, Robert B.—Plants of Oklahoma and Texas 24
Hancin, John—Plants of Kansas 30
Penland, C. W.—Plants of Venezuela 13
Seibert, R. J.—Plants of horticulture 6

By Exchange—

Brown, Clair A.—Plants of Louisiana 14
Carnegie Museum, Pittsburgh—Plants of Newfoundland, collected by Mrs. S. T. Brooks 144

Iowa State College, by George J. Goodman—Plants of Iowa, Oklahoma, and Arizona	139
Philadelphia Academy of Natural Sciences—Plants of eastern United States	70
Rocky Mountain Herbarium, by C. L. Porter—*Astragalus* sp. from Arizona	1
University of Michigan—Plants of Mexico and Central America	180
University of Minnesota Plants of Minnesota	329
By Transfer—	
Seibert, R. J. *Piper nigrum* L.	1
Total	1,616

STAFF
OF THE MISSOURI BOTANICAL GARDEN

THE GARDEN, 2315 TOWER GROVE AVENUE, ST. LOUIS, MISSOURI

GEORGE T. MOORE,
Director

HERMANN VON SCHRENK,
Pathologist

EDGAR ANDERSON,
Geneticist

JESSE M. GREENMAN,
Curator of Herbarium

ROBERT E. WOODSON, JR.,
Assistant Curator of Herbarium

CARROLL W. DODGE,
Mycologist

NELL C. HORNER,
Librarian and Editor of Publications

GEORGE H. PRING,
Superintendent

JOHN NOYES,
Consulting Landscape Architect

PAUL A. KOHL,
Floriculturist

WILLIAM F. LANGAN,
Chief Engineer

AUGUST P. BEILMANN,
Arboriculturist

JOSEPH LANGEN,
Assistant Engineer

DAVID C. FAIRBURN,
Horticulturist

ALBERT PEARSON,
Painter

JOSEPH CUTAK,
In charge of Exotics

LADISLAUS CUTAK,
In charge of Succulents

THE ARBORETUM, GRAY SUMMIT, MISSOURI

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MISSOURI BOTANICAL GARDEN BULLETIN

Vol. XXVIII MARCH, 1940 No. 3

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OF THE MISSOURI BOTANICAL GARDEN

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SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date to the death of Mr. Shaw, in 1889, the Garden was maintained under the personal direction of its founder, and while virtually a private garden it was, except at certain stated times, always open to the public. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was designated by Mr. Shaw as its official title and in his will and all of his writings he specifically referred to it as the "Missouri Botanical Garden." By a provision of Mr. Shaw's will the Garden passed at his death into the hands of a Board of Trustees. The original members of the Board were designated in the will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will, the immediate direction of the Garden is vested in a Director, appointed by the Board of Trustees. The Garden receives no income from city or state, but is supported entirely from funds left by the founder.

The city Garden comprises 75 acres, where about 12,000 species of plants are growing. There is now in process of development a tract of land of over 1,600 acres outside the city limits which is to be devoted to (1) the propagation and growing of plants, trees, and shrubs, designed for showing either indoors or outside, at the city Garden, thus avoiding the existing difficulties of growing plants in the city atmosphere; (2) gradually establishing an arboretum as well as holding a certain area as a wild-flower reservation, with the idea that possibly at some future time this may become the new botanical garden.

The Garden is open to the public every day in the year except New Year's Day and Christmas—week days from 8:00 a. m. until sunset; Sundays from 10:00 a. m. until sunset. The greenhouses are closed every day at 5:00 p. m.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Place, on the Sarah car line (No. 42). Transfer south from all intersecting lines.

CAMOENSIA MAXIMA

Missouri Botanical Garden Bulletin

Vol. XXVIII MARCH, 1940 No. 3

CAMOENSIA MAXIMA

"One of the Most Gorgeously Beautiful of Tropical Climbers"

This showy woody climber flowered at the Garden for the first time in January, 1928, producing a single flowering growth bearing but three flowers. The following season it again flowered, and was described in the Garden Bulletin, Vol. 17, No. 10. At that time it was stated that, judging from its behavior, it could not be regarded as a fast grower under greenhouse cultivation. However, since it has become established it has proved to be a rampant woody climber, demanding plenty of head room for its growth, which may exceed ten feet in a season. It has consistently flowered annually during January, and at the present time the plant is bearing over two hundred blossoms, snow-white flushed with gold at the time of opening. By the time that the flowers are fully open, a smoky atmosphere may have discolored the margins to a dark chocolate as shown distinctly in the photographs. Since the flowers are produced upon the current year's growth, control pruning should be done immediately after flowering.

The genus Camoensia consists of but two species, and Bentham states: "This genus stands alone in Leguminosae, as combining the lofty climbing woody stem and habits of many *Dalbergieae* with digitately trifoliate leaves of *Podalyrieae* and *Genisteae*, whilst the flowers place it among *Sophoreae*." The name Camoensia was given by Dr. Welwitsch as a tribute to the illustrious Portuguese poet, Luís de Camoëns (or de Camões). It is a woody

Flower and bud of *Camoensia maxima*

climber with long pendulous flowering branches, the young shoots, petioles and inflorescence having a peculiar brown scurfy deciduous woolly covering. The leaves are digitately trifoliate, somewhat resembling the poison ivy. The flowers are most peculiar in their formation, possessing bunches of milk-like petals which are tinged with gold on the fringed edge and finally dropping off from the vase-shaped calyx. Of the five segments the standard, which is fan-shaped and more than three inches in diameter, overhangs the four narrow lower ones. Looking up at the flowers one gets the effect of a fan, shielding the combined lower petals, the long filamentous stamens and the pistil. G. H. P.

TRAPEZE ARTISTS OF THE PALM HOUSE

"He flies through the air with the greatest of ease,
The daring young man on the flying trapeze."

Not long ago this song was on everyone's lips. And why not? It had a catchy tune and trapeze artists have always thrilled people. For the past few years trapeze performers have occupied the palm house in the main conservatory, and their aerial antics have been greatly enjoyed by countless children and grown-ups alike. Swinging with the greatest of ease they fly through the air and alight on the graceful leaves of adjoining palms. If the leap is not accurate they come hurtling down toward the ground; sometimes their plunge is broken by the dense undergrowth; again their leap lands them on the frail swaying ends of date-palm leaves, where they lose their precarious grip and land in the soft earth. Yet they arise with lightning agility and there they go up the trunk to try again. Despite these occasional mishaps, the writer has yet to see a dead performer or even one that has been injured in any noticeable way.

The trapeze artists of the palm house are none other than the cunning grey squirrels, scientifically known as *Sciurus carolinensis*. Cute little rascals are they and quite tame. The grey squirrel is a North American arboreal rodent and is said to be a larger and more powerful animal than its European cousin. Several broods make their home in the Garden and in adjoining Tower Grove Park. Some have even chosen the greenhouses for their abode, making their nesting places under the glass roof.

This isn't the first time that the Garden greenhouses have been used as a haven. Perhaps animal instinct has guided the birds and squirrels indoors where perpetual summer prevails and where it is possible to escape the cold, the rain, and the other harsh elements. During the warm months, when the ventilators are kept open, the birds fly in and out of the greenhouses at their will. The tall trees and thick vegetation afford a secure retreat wherein to build their nests and to rear their young. The strong fibers that clothe the trunks of palms serve as excellent material for constructing nests, and in the springtime visitors may notice the birds

plucking out strands of the matted fiber for this purpose. At one time more than ten pairs of grackles (blackbirds), with iridescent plumage, made their abode in the palm house, utilizing girders, vines and palm trees for nesting sites. Cardinals have made attempts to inhabit this conservatory but the noisy grackles have driven them out on every occasion ("Blackbirds in the Palm House," BULLETIN, October, 1928). However, the redbirds built several nests in other portions of the main conservatory, particularly in the thick vines of Bougainvillea, Clerodendron and the night-blooming Cereus.

For some unknown reason the chattering blackbirds have made an exodus from the greenhouses and the impish squirrels have moved in. Whereas the birds could get in and out only through opened ventilators during the summer season, two small openings near the rain spouts give the squirrels an opportunity to come and go when they please the whole year round. The squirrels have proven such an attraction that no attempt has been made to plug up the holes to keep them out.

The squirrels utilize available food of the outdoors such as horse-chestnuts, acorns, walnuts and gingko fruits, but they also feed upon the berries of various palms, particularly those of *Sabal Palmetto, Livistona chinensis,* and various species of Phoenix. It is a delight to watch these frisky animals as they straddle the pendent fruiting branches and pluck at the small berries. The palmetto and date palms have always produced sufficient seed, which, on ripening, fell to the ground and germinated, but since the squirrels now appropriate most of it very few reach the ground.

L. C.

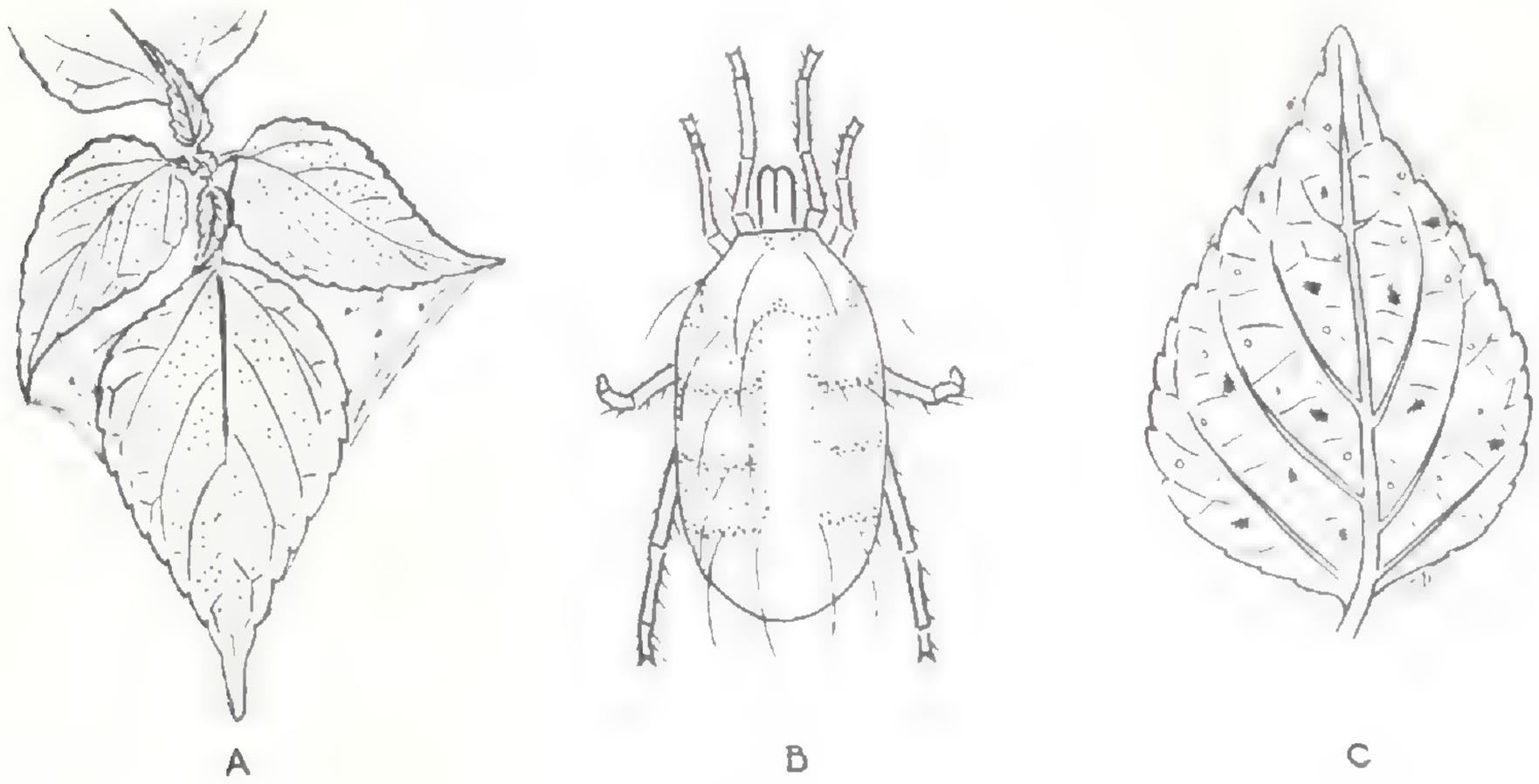
IDENTIFICATION AND CONTROL OF COMMON PLANT PESTS

PLANT PEST NO. 3—RED SPIDERS

Red spiders or mites are often very troublesome on house plants. The common name is rather misleading for they are not spiders although somewhat closely related. Neither are they true insects

for they have eight legs instead of six. In spite of these technicalities they can make a plant look awfully sick in a relatively short time. They attack nearly all kinds of plants and are found practically everywhere.

Red spiders are quite small, the adults being less than 1/64 inch long. In color they vary from pale green and yellow in the immature stages to orange and dark red as adults. Infested leaves often look as if they have been sprinkled with red pepper. Mites



A B C

RED SPIDER

A. Salvia leaf (× one-half), showing many tiny brown dots and fine web connecting them. This infestation has reached an advanced stage. B. Adult red-spider mite (× 80). The body is dull red. Note the sucking mouth part. C. Under-surface of Salvia leaf (× 2), showing habit of red spiders. Note the various sizes, the many spherical eggs, and a portion of the web which completely covers the leaf.

have sucking mouth parts like those of aphids and mealy bugs. They extract the plant juices, causing the leaves to become speckled a dull gray, turn yellow, curl up and drop prematurely. Infestations generally start on the under-sides of the leaves and soon spread to all parts of the plant. Delicate silken webs are formed which protect the mites and serve both as highways and as depositories for eggs.

The female lays about 75 eggs during a life span of four or five weeks. The number of generations a year depends on the climatic conditions. A hot, dry atmosphere is favorable to the

development of these pests, so in the house they remain active at all times and increase rapidly.

Control. A thriving infestation of red spiders is not easy to eradicate, so prevention is far better than cure. Always inspect plants carefully before bringing them into the house, even when they come from the florist or nursery. All house plants should be examined about once every two weeks just to make sure no hardy pioneers stake a claim.

The most effective way for indoor gardeners to combat red spiders is to wash the "bugs" off the infested plants with a forceful spray of cool water. Moisture is obnoxious to them and frequent syringing with water removes the webs, eggs and adults. Special attention should be given to the under-sides of the leaves. Certain lethal sprays, dusts and fumigants are recommended, but there is hardly any reason why it should be necessary to use such insecticides on house plants when a simple spray of water will do the job.

D. C. F.

THE PRUNING OF SHRUBS

At some time or other every gardener is confronted with the task of pruning. No matter what method is followed, nor what season is selected, he will be well within his judicial rights, since there is a precedent for every mistake as well as every correct cut. The art of pruning dates back to dim antiquity, and the succeeding generations have long ago exhausted the statistically possible errors. Probably no other horticultural art is so riddled with custom and habit—shrubs are pruned because they have always been pruned. The one method of avoiding mistakes and growing large plants—by simply not pruning—seems never to have become well established.

There are a number of reasons why shrubs are pruned. First of all, those which have outgrown the space allotted to them are always cut back, although this can hardly be considered a good reason. A more careful selection of planting material would yield greater satisfaction. Then there is the gardener who cannot resist the urge, each spring, to take pruning shears and get busy.

For this individual there can be no summer until he has pruned away all flowering wood from the unfortunate shrubs within his reach. After this, he whitewashes all nearby tree trunks and then blithely awaits the first robin. Actually very fine shrubs can be grown by not pruning at all, except to cut them to the ground periodically. The time to do this is when they become unsightly or when the interior and shaded portion is bare of leaves and full of dead branches. Many shrubs enjoy this treatment. It removes, temporarily at least, many insect pests and the very vigorous shoots quickly resume their characteristic growth. Lastly, there is the method known as "renewal pruning," which is a very satisfactory way of keeping a shrub border young and producing flowers.

Of the methods in use only "renewal pruning" needs much amplification. The system is simply the annual removal, during late winter or early spring, of the largest and oldest shoots. The oldest branches begin to lose their ability to produce an abundance of flowers shortly after reaching maturity. This is especially noticeable when there is competition with younger and more vigorous branches or plants and when water and food are inadequate. It is not possible to state a definite age when this happens, nor when pruning should begin; so much depends upon the vigor of the whole plant and its freedom from insect attack. However, it is suggested that the oldest shoots be removed when, by comparison with other plants or other parts of the same plant, they seem to have begun to decline. In the common bridal-wreath *(Spiraea Vanhouttei)* this may require ten years. With the common lilac *(Syringa vulgaris)* twenty years may elapse, while some species of honeysuckle *(Lonicera)* may not reach this stage before death.

In addition to what pruning method to use or whether to prune at all, there is need for some knowledge concerning the time when this work should be done. And so we come to the matter of rules. There is but one rule which has extensive application; and that concerns the time of pruning rather than the method. Since most shrubs are grown for flower production, it will not do to prune away those portions normally producing flowers. Those shrubs

which flower after June first should be pruned before this time and preferably in very early spring. Those which flower along with the first warm days of spring—and even until June first—should not be pruned until after blooming. In this group any removal of live wood usually reduces the number of flowers produced. However, as will be seen, even this simple rule is subject to many reservations and amendments. For instance, if the shrub border is not in bad condition and it is still possible to carry on a system of renewal pruning, we may disregard the rule covering the time of pruning. Renewal pruning can therefore be carried on each winter without reducing the number of flowers.

If we consider the Spiraeas we have a classical example of how difficult it will be to formulate simple rules for guidance in pruning. Almost every garden contains some species of Spiraea; some begin to flower in spring before the leaves unfold (*Spiraea prunifolia*); others (*Spiraea Billiardii*) do not flower until late summer. Thus, for this one genus almost every specialized type of pruning should be done. Renewal pruning is necessary for those blooming in early spring, since the flowers are produced on the wood of the past season and open before growth begins. Those developing flowers in late summer produce them as terminal inflorescences on the new growth of the current season, and therefore any pruning which stimulates the production of new shoots will also increase the number of flowers. At the same time the last type would be properly pruned if they were cut to the ground each winter. The early-flowering types, such as *Spiraea Vanhouttei*, might grow beyond the control exercised by renewal pruning and require cutting to the ground every ten years.

The most important equipment of the gardener contemplating pruning is not a sharp knife—as has often been said—but rather a thorough knowledge of the flowering habits of his plants, and the reasons why they are being grown.

The following list is an attempt to reduce pruning to a set of rules and regulations, although in some cases several rules or methods are proposed.

PLANT	SEASON TO PRUNE	REMARKS
Abelia grandiflora	any time	remove dead wood
Acanthopanax pentaphyllum	spring	remove dead wood
Albizzia Julibrissin	spring	may freeze to ground
Amelanchier sp.	AF spring	remove dead wood
Amorpha sp.	AF spring	annual vigorous pruning stimulates flowering
Amygdalus sp.	AF spring	remove root suckers
Aralia spinosa	any time	remove old trunks
Aronia sp.	AF spring	remove dead wood
Azalea sp.		needs little pruning
Baccharis halimifolia	spring	severe pruning when old
Benzoin aestivale	AF spring	remove dead wood
Berberis sp.	spring	shear as a hedge; remove dead wood as specimen
Buxus sp.	spring	usually sheared
Callicarpa sp.	early spring	needs little pruning unless frozen
Calycanthus floridus	AF spring	remove dead wood and very old shoots
Caragana sp.	AF spring	remove dead wood; very old shoots
Cephalanthus occidentalis	in spring	annual pruning stimulates flowering
Cercis canadensis	AF spring	remove dead wood
Chaenomeles sp.	AF spring	remove dead wood
Chionanthus virginica	in spring	remove dead wood
Cornus mas	AF spring	remove dead wood and suckers
Cornus stolonifera	in spring	renewal prune—cut to ground
Corylus sp.	in spring	remove dead wood
Cotinus, sp.	in spring	remove dead wood
Cotoneaster sp.	in spring	needs little pruning
Deutzia sp.	in spring	renewal pruning—cut to ground
Diervilla sp.	in spring	renewal pruning—cut to ground
Elaeagnus, sp.	in spring	remove dead wood in tree forms; renewal prune shrubby kinds
Evonymus sp.	in spring	remove dead wood
Exochorda sp.	in spring	remove dead wood
Fontanesia sp.	in spring	renewal prune
Forestiera sp.	AF spring	remove dead wood
Forsythia sp.	AF spring	remove dead wood—renewal prune

PLANT	SEASON TO PRUNE	REMARKS
Grewia sp.	in spring	remove dead wood
Halesia sp.	in spring	remove dead wood
Hamamelis sp.	AF spring	remove dead wood—renewal prune
Hibiscus syriacus	in spring	thinning top assists flowering
Hydrangea paniculata	in spring	reduce number of terminal shoots
Hydrangea arborescens	in spring	cut to ground annually
Kerria japonica	in spring	renewal prune
Kolkwitzia amabilis	in spring	renewal prune
Ligustrum sp. (except when used as a hedge)	in spring	renewal prune when full-grown; cut to ground when unsightly
Lonicera sp. (shrubby types)	in spring	renewal prune when full-grown; cut to ground when unsightly
Mahonia Aquifolium	in spring	remove dead wood
Philadelphus sp.	in spring	renewal prune when possible; cut to ground when unsightly
Physocarpus sp.	in spring	renewal prune—cut to ground
Pyracantha coccinea	AF spring	remove dead wood
Ribes sp.	AF spring	renewal prune—cut to ground
Robinia sp.	in spring	head back to two feet
Securinga ramiflora	in spring	head back annually
Sorbaria, sp.	in spring	head back—cut to ground
Spiraea Vanhouttei, *Spiraea prunifolia*, etc.	AF spring	renewal prune when possible; cut to ground when necessary; don't head back
Spiraea Douglasii, *Spiraea Billiardii*, etc.	in spring	heavy pruning produces new shoots which flower same summer
Symphoricarpos sp.	in spring	cut to ground when unsightly
Syringa villosa	in spring	remove dead wood and old flower spikes
Syringa sp. (named varieties)	AF spring	remove dead wood, old flower spikes, root suckers
Tamarix sp.	in spring	can be headed back annually, or left grow like a tree
Viburnum sp.	in spring	renewal prune as long as possible, cut to ground if necessary

The above list does not include every shrub grown in this locality; the gardener in possession of an unusual shrub generally has a definite idea of its use and possibilities and therefore pruning is not a problem. Under the heading "Season to Prune," the notation "in spring" means that the work can be done as long as the plant is dormant, either fall, winter or spring. The note "AF spring" means: after flowering has finished in spring. At this time many branches bearing leaves will be removed when renewal pruning is practiced—no harm will result. A. P. B.

SUNSHINE (?) IN FEBRUARY

Since 1931 a record has been kept of the hours of sunshine at the Arboretum, thirty-five miles southwest of the city, in order to compare it with the amount registered at the city Garden. The average for the month of February for the past eight years has been 118 hours in town, and at the Arboretum it was 20 hours more.

This February the total number of hours of sunshine in St. Louis was 58, a trifle less than half the normal amount, while at the Arboretum the regular average excess was maintained over that of the city, 20 hours. Since many plants are more or less dependent upon bright sunlight for their flowering, the past month was particularly trying for growers planning to use forced material for the Greater St. Louis Flower and Garden Show at the Arena. The least amount of sunshine in February for St. Louis in the previous eight years was 99¾ hours in 1935. The greatest amount was 159¼ hours in 1933. The maximum for the Arboretum was 172½ in 1933 and the minimum 121 hours in 1931.

NOTES

Dr. George T. Moore, Director of the Garden, spoke before the St. Louis Women's Club, March 7, on "California vs. Missouri, Horticulturally Speaking."

The botany class from Southern Illinois State Normal University, with Prof. Walter B. Welch in charge, visited the Garden February 26.

Mr. Ladislaus Cutak, in charge of Succulents at the Garden, gave an illustrated lecture, "Foot-loose in Mexico," before the St. Pius Holy Name Society, March 12; and on March 14, he spoke before the St. Louis Florist Club, on "The Quest for Plants in Mexican Deserts."

Mr. L. P. Jensen, Manager of the Garden Arboretum, spoke before the members of the Marguerite Krueger Conservation Club, February 22, on "The Henry Shaw Gardenway"; and on March 7, he gave an illustrated talk before the members of the Washington Garden Club, Washington, Mo., on "Steps in Landscape Design."

Recent visitors to the Garden include: Mrs. Edward J. Rodeman, of the Jefferson City Garden Club; Mrs. Vincent Kolkmeyer, Botanist of the Missouri Research Museum, State Capitol, Jefferson City, Mo.; Dr. F. Lyle Wynd, Assistant Professor of Botany, University of Illinois, Urbana; Dr. Paul B. Sears, Head, department of botany, Oberlin College.

Mr. Ladislaus Cutak, in charge of Succulents at the Garden, has recently been elected honorary vice-president of the Cactus and Succulent Society of America "in recognition of outstanding service in the preceding year for a better understanding of xerophytic plants, . . . who, by writings and lectures, has brought knowledge of cacti and other succulents to many people."

Mr. George H. Pring, Superintendent of the Garden, spoke on "The St. Louis Flower Show" over Radio Station KMOX, March 5 and 8, over KSD, March 9, and KXOK, March 13. On March 1, assisted by Mr. Paul A. Kohl, Floriculturist to the Garden, he showed Mr. Kohl's colored pictures of the "Garden Floral Displays Throughout the Year" at the meeting of the St. Louis Horticultural Society; and on March 7 these pictures were shown at the Tyler Place Presbyterian Church.

The February number of the ANNALS OF THE MISSOURI BOTANICAL GARDEN (Vol. XXVII, No. 1) has recently been issued, with a paper by G. T. Johnson on "Contributions to the Study of the Trypetheliaceae," and one by H. N. Andrews, "On the Stelar Anatomy of the Pteridosperms, with Particular Reference to the Secondary Wood."

Dr. Edgar Anderson has received a grant-in-aid for 1940 of $900 from the American Philosophical Society of Philadelphia to be used in monographing the genus *Tripsacum* which is of special interest because of its close relationship to Indian corn. The taxonomic work will be carried on by Dr. Hugh C. Cutler under the joint auspices of the Missouri Botanical Garden, Washington University, and the Texas Agricultural Experiment Station.

STATISTICAL INFORMATION FOR FEBRUARY, 1940

GARDEN ATTENDANCE:	
Total number of visitors	15,386
PLANT ACCESSIONS:	
Total number of plants received as gifts	14
LIBRARY ACCESSIONS:	
Total number of books and pamphlets bought	19
Total number of books and pamphlets donated	523
HERBARIUM ACCESSIONS:	
By Purchase—	
Cronquist, Arthur—Plants of Idaho and Utah	625
Hoogstraal, Harry—Plants of Mexico	474
Looff, Mrs. Henry B.—Plants of Kodiak Island, Alaska	97
Williams, Louis O.—Orchids of Mexico	100
By Gift—	
Baxter, R. W.—Plants of Hawaii	134
Brown, William L.—*Poa stiriaca* Fritsch & Hayek from Bosnia	1
Cheesman, E. E.—*Bonafouria undulata* (Vahl) A. DC. from the West Indies	1
Clark, Robert B.—Plants of Oklahoma and Texas	44
Cutler, Hugh C.—Plants of western United States	325
Daniel, Hermano—Plants of Colombia	2
Field Museum of Natural History Plants of Mexico	6
Kenoyer, L. A.—Plants of Mexico	75
Penland, C. W.—*Ephedra* sp. from Ecuador	1
Seibert, Russell J.—Bignoniaceae	36
By Exchange—	
Daily, William A.—Freshwater algae, chiefly from Indiana	20
Gray Herbarium, Harvard University—"Plantae Exsiccatae Grayanae," Cent. X	100
Gray Herbarium, Harvard University—Miscellaneous duplicates	84
Hermann, F. J.—Plants of eastern United States	74
New York College of Agriculture, Cornell University—Plants of Whatcom County, Washington	102
Smarods, J.—Plants of Latvia	28
By Field Work—	
Woodson, R. E., Jr.—Plants of Panama	444
Total	2,773

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A. H. TIMMERMAN,
President of The Academy of Science of St. Louis

MARK D. EAGLETON
President of the Board of Education of St. Louis

Secretary
GERALD ULRICI

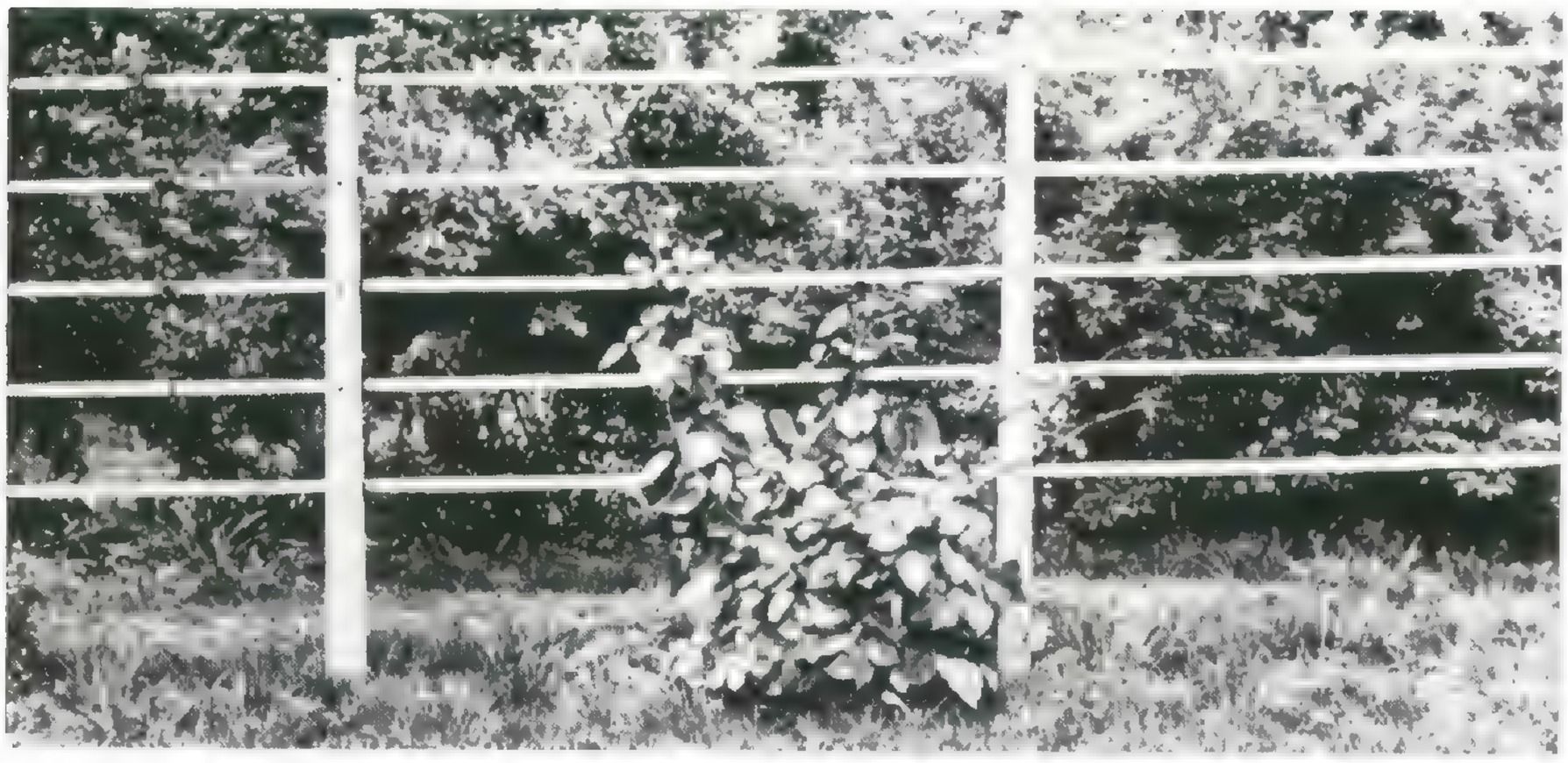
SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date to the death of Mr. Shaw, in 1889, the Garden was maintained under the personal direction of its founder, and while virtually a private garden it was, except at certain stated times, always open to the public. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was designated by Mr. Shaw as its official title and in his will and all of his writings he specifically referred to it as the "Missouri Botanical Garden." By a provision of Mr. Shaw's will the Garden passed at his death into the hands of a Board of Trustees. The original members of the Board were designated in the will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will, the immediate direction of the Garden is vested in a Director, appointed by the Board of Trustees. The Garden receives no income from city or state, but is supported entirely from funds left by the founder.

The city Garden comprises 75 acres, where about 12,000 species of plants are growing. There is now in process of development a tract of land of over 1,600 acres outside the city limits which is to be devoted to (1) the propagation and growing of plants, trees, and shrubs, designed for showing either indoors or outside, at the city Garden, thus avoiding the existing difficulties of growing plants in the city atmosphere; (2) gradually establishing an arboretum as well as holding a certain area as a wild-flower reservation, with the idea that possibly at some future time this may become the new botanical garden.

The Garden is open to the public every day in the year except New Year's Day and Christmas—week days from 8:00 a. m. until sunset; Sundays from 10:00 a. m. until sunset. The greenhouses are closed every day at 5:00 p. m.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Place, on the Sarah car line (No. 42). Transfer south from all intersecting lines.



The Kudzu vine, on May 22, 1939

The vine as it appeared June 15

The vine on Aug. 22

THE KUDZU VINE *(Pueraria Thunbergiana)*

Missouri Botanical Garden Bulletin

Vol. XXVIII APRIL, 1940 No. 4

THE KUDZU VINE

When choosing a vine to cover a trellis quickly or to hide some unsightly object why not consider the Kudzu vine? *Pueraria Thunbergiana* is its botanical name and it is native to China and Japan. The leaves are large, the entire plant making a bold mass of foliage. The speed with which one established plant will cover a large area in a few weeks' time is amazing. Kudzu likes a warm soil, and on that account only commences growing in early May. It is almost unbelievable, except for picture records, that a few tender shoots in May will effectively screen a wide area in late June. The first frost will brown the foliage and kill the young shoots but the heavier stems will survive a mild winter. Should the temperature reach zero the vine will freeze to the ground but new shoots will spring from the roots. For good exercise try digging a ten-year-old root system of a Kudzu vine. The section shown in fig. 1 measured twenty-four inches in length and three inches in thickness, and this was only a small portion of the root system.

Established plants, or such as have not been frozen to the ground, will bloom freely during the summer months. Kudzu is a legume, the purple pea-shaped flowers being borne in axillary spikes. There are many flowers but they are partially hidden by the large leaves. The fragrance, which is most delightful, very much resembles that of grapes. One plant at the Garden covers an arched trellis, and invariably visitors passing under this arch stop to investigate the source of this captivating odor. The hairy seed-pods measure about two and one-half inches in length but

each pod contains only two to five viable bean-shaped seeds which measure one-eighth inch in length.

Kudzu vines may be started from seeds in the spring but a few years are required before the plants produce the characteristic

Fig. 1. Tuberous root of the Kudzu vine.

heavy growth. Occasionally plants will appear from self-sown seeds. For quicker results it is better to purchase two- or three year-old plants from nurserymen. Other methods of increasing the plants are by division and layering.

It is customary when singing the praises of a plant to balance the good qualities with the disagreeable pest-control program

but fortunately in this instance we can say that, so far as we know, there are no insects or diseases to harass this vine and what is more it is drought-resistant.

In this country the Kudzu vine is being extensively used in soil

Fig. 2. Flowers of Kudzu vine.

Fig. 3. Seed-pods of Kudzu vine.

erosion work and to some extent as a forage plant. The Chinese make flour from the roots and weave the fiber into cloth popularly known as grass linen. Beneficial and harmful drugs are also extracted from the roots and stems. P. A. K.

SWEET CORN WITH A COLLEGE EDUCATION

Until recently the St. Louis gardener who wished a supply of sweet corn for the table was caught between the horns of a dilemma. He had to choose between a northern variety not adapted to this climate or one of the better field corns picked at

the roasting-ear stage. Neither of these courses appealed to a discriminating gardener. The northern sweet corns, brought this far south, tasseled too early and produced little "nubbiny" ears, while in dry years or in dry situations they often produced no ears at all. The "roasting ear" corns grew well, particularly on a good piece of corn land, and they produced large well-filled ears, but they were scarcely an acceptable substitute for true sweet corn. Even when picked young they were not really sweet and the more they matured, the more strongly did they acquire the flavor of laundry starch. One had the feeling that he was eating a high-grade horse food in lieu of a table vegetable.

But Missouri gardeners no longer need despair of growing green corn for the table since sweet corn, like field corn, has been to college. In the great cooperative corn-breeding program undertaken in the last two decades by the agricultural colleges, experiment stations, and seed companies of the corn belt, sweet-corn breeding has had a share. As a result there are now becoming available in the trade a number of hybrid sweet corns, adapted to the home garden. Like the hybrid field corns which have been so successful that even the average city dweller is hearing about them, these hybrid sweet corns are the result of a long and intricate breeding program. From the original stocks selections were made year after year, the tassels and silks being covered with paper bags to prevent the inter-crossing which ordinarily takes place and the silks of each plant dusted with the pollen from its own tassels. A weird way to produce superior corn, for each season saw the selections becoming smaller. Many of the lines died out altogether, but the runts were being eliminated and hidden weaknesses brought to light. Even the best of the strains which at last emerged, though uniform, were distinctly inferior in appearance to the average of the original stocks. But cross two of these selected inbreds together and learn that in corn breeding, as in many other matters, it does not pay to put too much trust in appearances! The corn which grows from these crossed inbreds is tall and strong, with fine long ears. The plants are amazingly uniform. Looking down a row, tassels all at the same height, ears the same shape and size, one who is used to ordinary fields of corn

has the feeling that he is looking at a machine-made product. It is as though one had selected one of the best plants from a corn field and then by some miraculous machine had made a thousand copies of the original.

The first of these hybrid seed corns to reach the seed market originated in the North. This was only natural, since it is there that sweet corn has been longest grown and there that it is a standard bill-of-fare every summer. These crossed inbreds of northern origin have not done as well in St. Louis as in the North, but even here they have produced a usable crop in all but the driest years. Meanwhile other inbreds from closer at hand have made their appearance in the trade and the best of those now available should satisfy the most critical gardener.

Eight of these crossed inbred sweet corns were grown in a small experimental plot at Gray Summit during the summer of 1939. Of those which are already in commercial production, the most satisfactory was "Ioana." The earliest plantings were in their prime the 20th of July, the last plantings were ready for table use between the 8th and the 17th of August. The plants were remarkably uniform, even for a hybrid corn. Every stalk bore one large, well-filled ear, and in the later plantings most of the stalks carried a smaller but well-shaped ear. Particularly noticeable was the almost complete absence of nubbins, even in rows which had been too thickly planted.

"Ioana" is a cross between two selections from "Golden Bantam." One of these was originally started at Purdue University in Indiana, the other at the Experiment Station at Ames, Iowa. Technically known as "Iowa 45 × Purdue 39," the hybrid was given the popular name "Ioana," a portmanteau expression for Iowa × Indiana. To the average gardener its only objection is that, like all crossed inbreds, it does not breed true from seed and must be purchased from the breeder (or his agent) every spring. For the small quantity used by the home gardener, the difference in price between the hybrid seed and ordinary sweet corn is but a trifle, and is more than compensated by the better quality, higher yield, and greater reliability of the best hybrid varieties.

E. A.

A REVIEW OF *DENDROBIUM SUPERBIENS*

For many years, orchid enthusiasts from various parts of the world have discussed the parentage of this elusive hybrid from Australia. *Dendrobium Phalaenopsis, D. bigibbum, D. undulatum* and recently *D. veratrifolium* have all been suggested. The writer's part in the discussion will consist of bringing together most of the references from the literature.

During 1915 an importation of orchids, supposedly all *D. Phalaenopsis,* was received from Australia through Stuart Low & Co., Enfield, England. However, in addition to *D. Phalaenopsis,*

1 2

Fig. 1. Parents and progeny: left to right, (1) the first plant grown at the Garden since 1915, showing characteristic fusiform pseudobulbs of *D. undulatum;* (2) typical *D.* "Louis Bleriot" likewise in the collection since 1915. The growth resembles *D. Phalaenopsis.* The reader might question height, but many of our own Garden-raised *D. Phalaenopsis* measure 30 inches; (3) *D. Phalaenopsis,* rather a poor specimen, but the only plant carrying flowers at the time of photographing (Feb. 1, 1940). This is the first time we ever managed to get the entire group in bloom at this date; (4) typical *D. undulatum.* Note height of pseudobulbs, number of leaves which decrease in size toward the top; (5 and 6) hybrids of recent importation, (5) with light mauve flowers, (6) with dark mauve.

Fig. 2. Top row: *D. Phalaenopsis* and *D. undulatum;* below, left, two flowers of the natural hybrid *D.* "Louis Bleriot." Note white-margined sepals; right (below *undulatum),* flowers of *D. superbiens* raised at the Garden. Note linear twisted sepals and petals. The 4 lowest flowers are from the most recent importation and show variation in color.

there was finally identified *D. bigibbum, D. superbiens,* and one hybrid which was a puzzler. It did possess the characteristic white-margined sepals and petals of *D. superbiens* and was described under that name in the Garden Bulletin (Vol. 21, p. 142. 1933).

Recently, while visiting the orchid range of Sherman Adams, Wellesley, Mass., Mr. Adams drew my attention to one of his new purchases, *Dendrobium* "Louis Bleriot." It had been raised in France by Vacherot in 1929, and was a progeny of *D. Phalaenopsis* var. *Schroderianum* and *D. superbiens.* Being in full bloom at the time, it was immediately recognized as the same plant as the

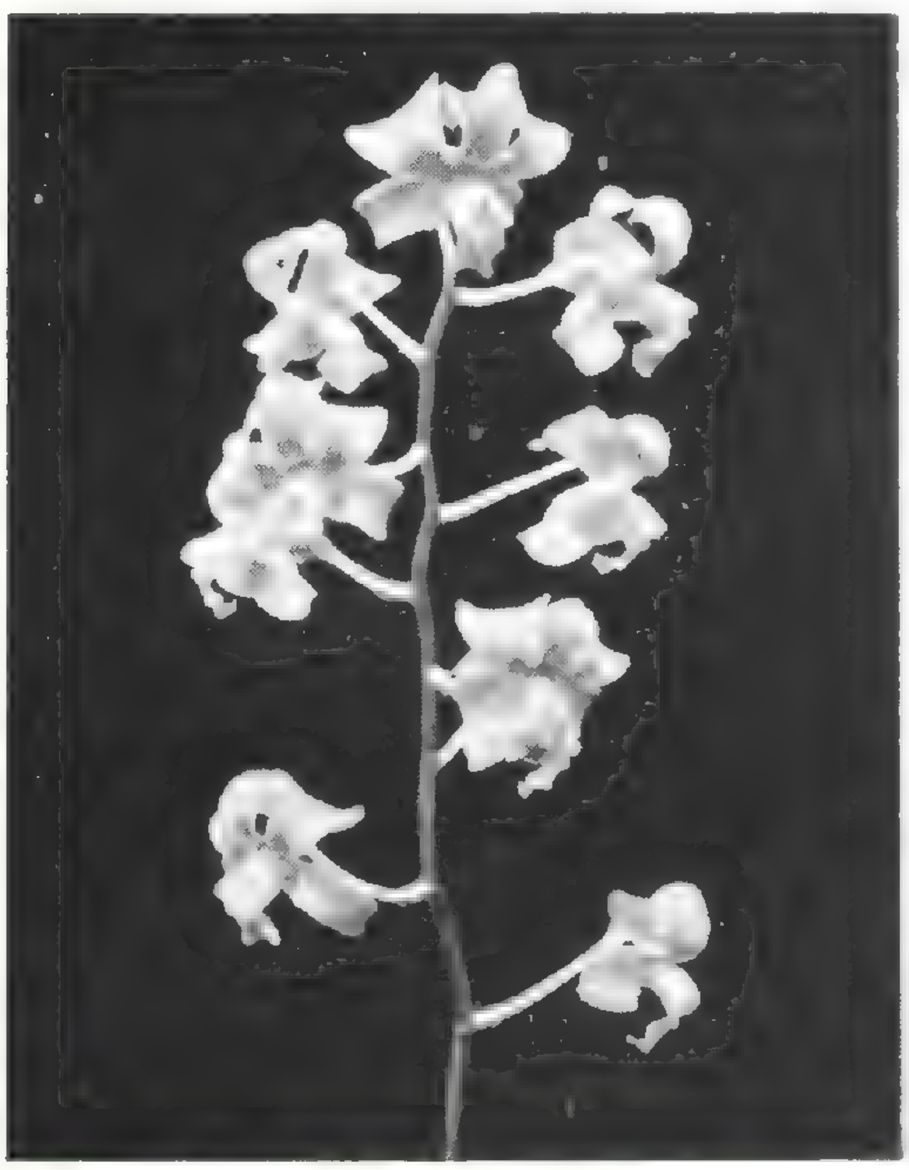


Fig. 3. Dendrobium hybrid imported from Australia in 1915, showing erect flower spike.

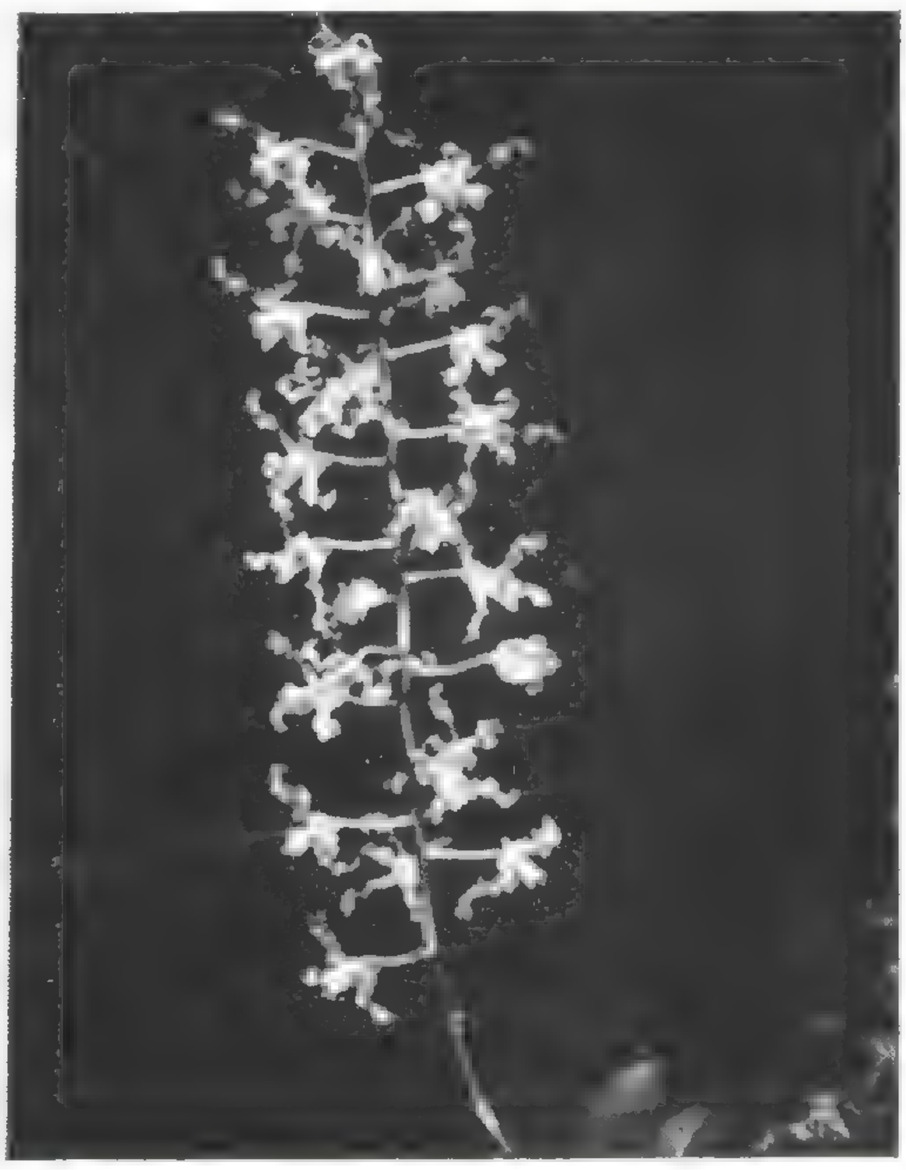


Fig. 4. Typical *Dendrobium undulatum,* showing erect flower spike and characteristic sepals and petals (see Bot. Cook's Voyage, p. 111, *t. 299).*

puzzling one received from Australia in 1915. Again Nature must be credited with making the first hybrid, for the same cross was made in Tokyo, according to the *Orchid Review* (1923, page 355). Its vigorous growth resembles *D. undulatum,* and the cane shape is that of *D. Phalaenopsis.* The flowers are very dark mauve like those of *D. bigibbum* but smaller. The dominant character of *D. undulatum,* the white margins of both sepals and petals, is

shown. The puberulous ridges of the crest of the lip are characteristics of either *D. Phalaenopsis* or *D. bigibbum*. Its flowering period is intermediate between that of the parents, perhaps nearer *D. superbiens*. Consistent flowering periods of the group show: *D. Phalaenopsis*, October-December; *D. bigibbum*, November-January; *D. undulatum*, October-March; *D. superbiens* and *D.* "Louis Bleriot," December-February. An interesting fact, recorded for several years in the orchid show at the city garden, is that *D. undulatum* is the most resistant to smoke palls, *D. superbiens* and *D.* "Louis Bleriot" less so, while *D. Phalaenopsis* and *D. bigibbum* are decidedly sensitive.

In the *Orchid Review* (Vol. 40, page 246), Mr. R. F. Leaney, of Sidney, Australia, stated that he had observed a hybrid growing among "large quantities of both parents [*D. Phalaenopsis* and *D. undulatum*] and in places that in the past have been simply covered with *D. Phalaenopsis* and *D. undulatum*. The fact that this plant [*D. superbiens*] grows in fairly large colonies, but only in very few places and not scattered over districts, lends colour to my suggestion that it is a natural hybrid."

In August, 1937, 260 plants, presumably of *D. Phalaenopsis*, were received at the Garden from Mr. Leaney. The following season all of them were found to be *D. bigibbum (Bot. Mag. pl. 4898)*. A study of the plants in the shipment for the past two flowering seasons showed that the average growth is 18-24 inches, shaped like *D. Phalaenopsis* and green with prominent lines of deep purple. The old stems were brown, whereas *D. Phalaenopsis* has green stems and membranous bracts. The flower spikes are pendant, supporting 4-12 dark mauve flowers varying from one inch (suggesting *D.* "Louis Bleriot") to 2½ inches across. A lighter color is extremely rare, in which case the sepals have white margins.

The new growth of *D. superbiens* is 24-30 inches, enlarged at the middle, lined with green-purple, brown with age; leaves 10-15, with purple margins; flowers light mauve to dark mauve; sepals and occasionally petals white-margined; spikes usually erect (one specimen pendant like the Garden-raised specimens described in the Garden Bulletin Vol. 21, *pl. 41)*.

Parental characters noted from *D. undulatum:* vigorous growth,

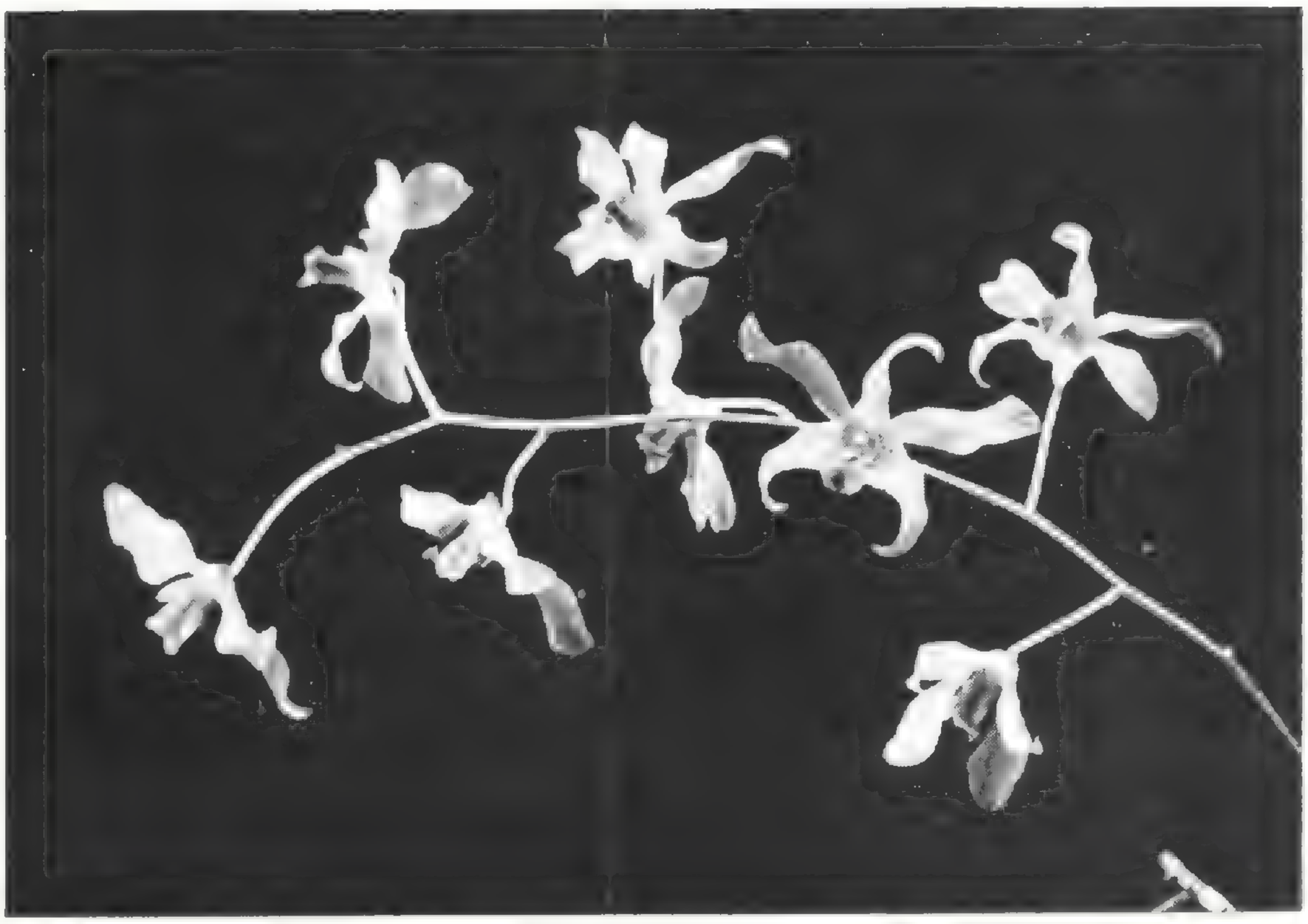


Fig. 5. Top: Hybrid *Dendrobium superbiens* with pendant spikes, raised at the Garden; bottom: *Dendrobium* "Louis Bleriot" imported from Australia in 1915, proving to be identical to the plant raised by Vacherot of France.

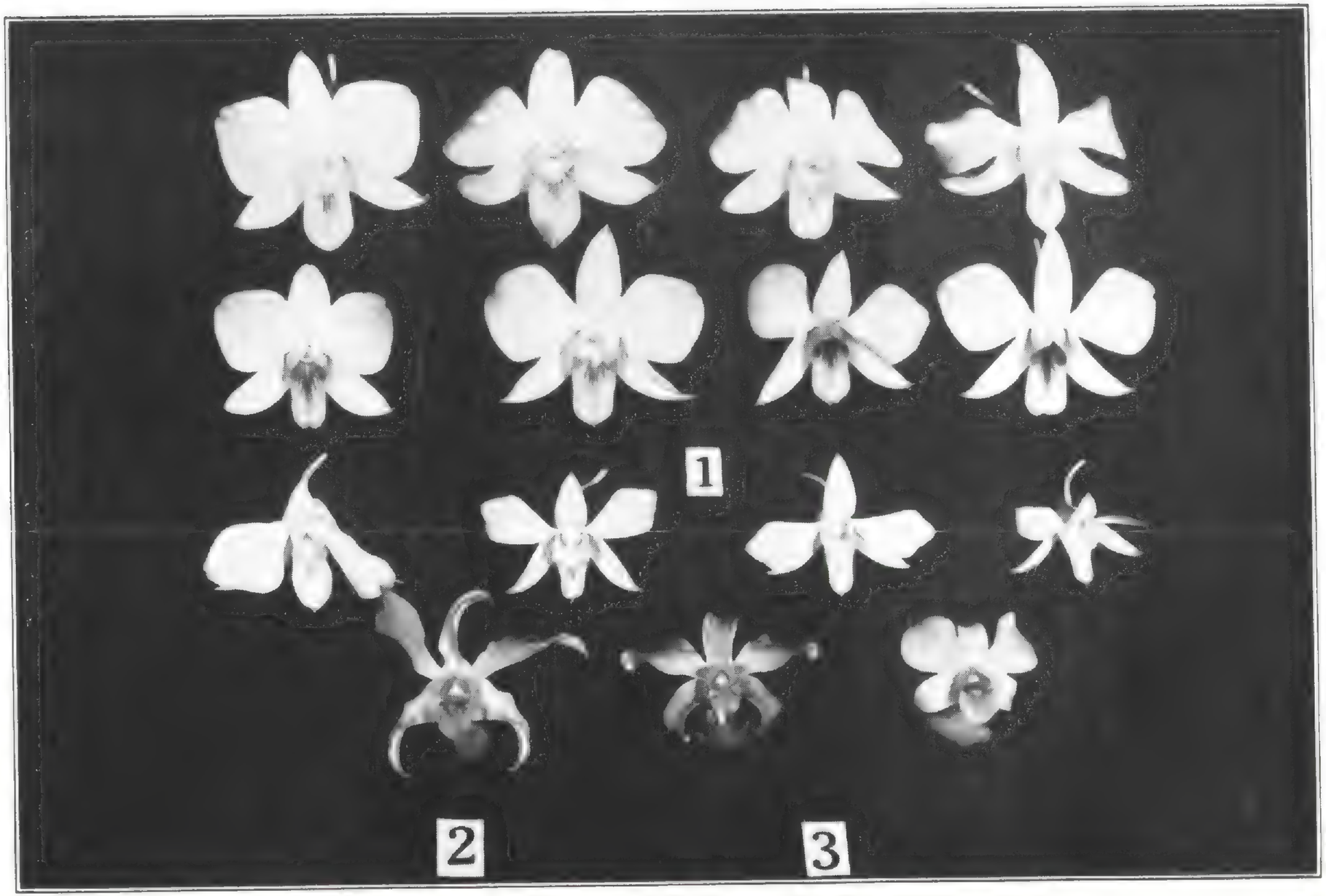
fusiform shape, increase in number and size of leaves; vertical spikes; petals twisting or rolling; serrulate erect keels; longer and later flowering period; greater resistance to sulphur in the atmosphere. If growing in the same area as *D. Phalaenopsis* or *D. bigibbum:* pseudobulbs cane-shaped with white membranous bracts; flower spikes pendant; petals rhomboid-orbicular; five to seven obscure puberulent ridges; prominent spur; variable mauve color, particularly in association with *D. Phalaenopsis.*

Fig. 6. *Dendrobium bigibbum* imported as *D. Phalaenopsis* in 1937 (see *Bot. Mag.* 1856: *pl. 4898).*

PUBLICATIONS REVIEWED

D. bigibbum (Bot. Mag. 1856, *t. 4898).*—Contains colored illustration of a specimen grown by Mr. Loddiges in November 1855, and "received from Dr. Thomson, who found it on Mount Adolphus, Torres Straits, on the northeast coast of New Holland."

D. superbiens (Orchid Album. Vol. 7, *t. 312.* 1878).—Colored illustration of plant "discovered and sent home by our collector, Mr. Goldie, in the year 1877, from Torres Straits on which abut the northern extremity of Australia and the southern shore of



1. Forms of *Dendrobium Phalaenopsis* flowers grown from seed. 2. Flower of *D. superbiens* raised at the Garden. 3. Flowers of *D. superbiens* (left) and of *D.* "Louis Bleriot" (right). 2 and 3 show pale rose margins characteristic of *D. superbiens*.

the Island of New Guinea." The flowers are said to be "rosy purple, bordered with white, . . . and continue in beauty for three months." The illustration was taken from a specimen grown by M. le Duc de Massa, Chateau de Francouville, par Luzarches, France.

D. Phalaenopsis (Bot. Mag. 1885, *t. 6817).*—A colored illustration of two spikes of flowers. Article quotes Mr. Fitzgerald as stating: "that he regards this as the finest of Australian orchids . . . and closely allied to *D. bigibbum,* Lindl., *superbiens,* Reichb., and *Goldiei,* all natives of the same botanical region."

D. Goldiei (The Garden, vol. 14, *pl. 4.* 1878).—A colored plate shows two pendant flower spikes. Flowers more red than mauve, sepals lighter mauve and margined with white. Side lobes of the lip mostly shielding the column; base of the lip showing 5-7 dark ridges. Pseudobulbs green at the nodes, narrowed towards the apex, typical of *undulatum.* "This beautiful species, at one time thought to be *D. superbiens,* but now found to be distinct."

D. superbiens (Sander's *Reichenbachia,* vol. 1, page 87, *pl. 39.* 1888).—A beautiful colored plate showing one erect and one pendant spike. Pseudobulbs and shape and color of flowers correspond with hybrids raised at the Garden and Low's of England. The plate is captioned *D. superbiens,* whereas the description is headed *D. superbum,* evidently a printer's error.

D. Leeanum (Orchid Review, vol. 31, page 355. 1923).—Imported by Sander and described as a new species by Mr. Jas. O'Brien. The late Mr. Rolfe of Kew "suggested that it might be a natural hybrid between *D. Phalaenopsis* and *D. superbiens"* and noted that the crest of *D. superbiens* "consists of three serrulate erect keels at the base of the front lobe, but in *Phalaenopsis* the disc is simply puberulous without any crest." Several thousand flowers of *D. Phalaenopsis* and *D. bigibbum* examined at the Garden show that both have the same type of disc. *D. undulatum* has three definite serrulate erect keels, while the keels of *D. superbiens* will vary from three to seven. This variation, combined with white margins on the sepals and infrequently the petals, is a dominant character inherited from *D. undulatum.*

"*Dendrobium superbiens,* a Natural Hybrid," by G. H. Pring (*Mo. Bot. Gard. Bull.,* vol. 21, page 142. 1933).

D. superbiens (Mo. Bot. Gard. Bull., vol. 22, page 141. 1934). —Reply by Gurney Wilson to the above note: "The notes on *D. superbiens* have no doubt been read with interest by many orchid folk who have hitherto regarded the plant as a species. That *D. superbiens* is a hybrid between *D. Phalaenopsis* and *D. undulatum* has definitely been proved by the seedlings raised in the Missouri Botanical Garden. The recording in 1932 of hybrids of similar parentage under the respective names, 'Pauline' and 'Greystone,' brought forth a note from Mr. R. E. Leaney that he had discovered 'Pauline' in the form of a natural hybrid, in places that in the past have been simply covered with *D. Phalaenopsis* and *D. undulatum.*"

D. superbiens: ("Is it a Hybrid of *Dendrobium bigibbum* and *D. undulatum?*" *Australian Orchid Review,* vol. 3, page, 29. 1938).—Reference is made to D. H. L. Lyon, Director of the Experimental Station of the Hawaiian Sugar Planters Association, who has raised hybrids between *D. bigibbum* and *D. undulatum* which he states are typical *D. superbiens.* Concerning the natural locality he writes: "In all places where *D. superbiens* occurs there also is found *D. bigibbum* and *D. undulatum.* West of Cooktown, where *D. Phalaenopsis* is found in such large numbers, *D. undulatum* is conspicuous by its absence. Neither are there any *superbiens* to be found."

D. superbiens: ("Is *D. superbiens a Hybrid?*" by R. E. Holttum, in *Australian Orchid Review,* vol. 3, page 117. 1938).—Dr. Holttum, Director of Botanic Gardens, Straits Settlements, possesses hybrids between *D. veratrifolium* and *D. bigibbum* and states: "These hybrids approximate closely to our *D. superbiens,* except that the flowers are smaller and less deeply coloured." He suggests that "doubtless the wild plants are a mixture of hybrids, and are the results of many generations of selfing and possible back crossing."

D. undulatum, (Specimens identified: Banks and Solander's *Illustrations Australian Plants Collected during Captain Cook's Voyage,* vol. 3, *t. 299.* 1905.

VARIABILITY OF SPECIES

Collecting expeditions since 1923 in Central and South America have given the author an excellent opportunity to study the variability of species in the "wild." Upwards of 4,000 plants of *Cattleya Trianae, C. Schroederae* and *C. gigas* have been collected. The *C. Trianae,* known to the natives as Tulipans, presents remarkable variation, the pseudobulbs and leaves ranging from short and stout to long and narrow. Sunlight is definitely a factor in growth. The sturdier plants are always found in exposed positions, and the more elongated growth in shadier locations upon the trees. The following season under cultivation the flowers showed variations in size and in color from pure white and light mauve to dark mauve.

Plants of *Brassavola nodosa* have been collected in Panama on both the Atlantic and Pacific coast. They were growing in clumps upon low-growing trees, their growth averaging about ten inches. Those on the Pacific coast were much stronger, influenced by a greater precipitation of rain. North of the Canal Zone, on the Atlantic side at El Valle, at an elevation of 2,000 feet, more or less terrestrial pygmy-flowered specimens were collected from large boulders. *Phragmopedilum caudatum* was also noted in pygmy form. Farther north, bordering Costa Rica, the same orchids were collected, at an elevation of 4,000 feet, where they were growing upon tall trees. A most unusual plant adaptation was the epiphytic genus Stanhopea growing under bushes in leaf mold. They would possibly have been passed unobserved if they had not been in full bloom and fragrant.

Variability in hybrids is often beyond expectation. Within the past ten years upwards of 10,000 hybrids of varied genera have flowered in the greenhouses at the Garden. First-generation crosses between *Phalaenopsis Schilleriana* and *P. amabilis* have produced some progeny with the mottled foliage of *Schilleriana* and the white flowers of *amabilis,* and some with the leaves of *amabilis* and the pink flowers of *Schilleriana.* However, *amabilis* was the dominant parent, most of the plants possessing dark green leaves and white flowers flushed with pink around the base of the sepals and petals. The number of flowers was increased by *Schilleriana* parentage. Brassavola parentage is dominant over Cat-

tleya, but the revolute sepals from Brassavola is an annoying factor to hybridists. The Cattleya color is of course dominant. One of the Garden's best hybrids is *C. Trianae* × *Brassocattleya Fournierae (B. Digbyana* × *labiata)* × *(C. Trianae* × *B. C. Fournierae),* in which the growth is the same as noted in the "wild" with *C. Trianae* and the flowers are larger than in the parents. Color varied from pure white to light and medium mauve. Other forms (often referred to as "runts" for the discard) possessed narrow and revolute sepals and petals. G. H. P.

MISSOURI BOTANICAL GARDEN ORCHID SHOW, FEBRUARY, 1940

The following article by Mr. G. H. Pring, Superintendent of the Garden, from the *American Orchid Society Bulletin* (March, 1940) is herewith reprinted:

"The general effect of the 1940 Orchid Show at the Missouri Botanical Garden was probably even more pleasing to the orchid lover than to the general public. In years past, often one did not see the orchids for the beauty of the staging. This year, to avoid not seeing the trees for the forest, as it were, the shadow boxes in which the plants were displayed were painted a soft, dull green, as nearly like the color of the orchid foliage as possible. Additional interest was given the show by center formal beds of primroses, and cyclamen in the various orchid colors, intermingled with white Pelargoniums, while the boxes and niches of orchids stood out beautifully against the cool, restrained background. The usual naturalistic display of orchids at the far end of the Floral Display House looked really natural, for the first time in the history of the show, and the general effect, as one viewed the display as a whole, was one of restrained good taste and beauty.

"Thirty shadow boxes, arranged in groups of three around the wall, were broken occasionally by four large niches, the whole line being backed by our permanent planting of Ficus. In making the circle tour of the show, the first shadow box contained *Cattleya Trianae* and the very fragrant Flor de Mayo, *C. Schroederae,* both from Colombia. Like the other shadow box groups,

this one was covered on top with a group of Dendrobiums of the Nobile type, raised from seed in St. Louis.

"The first large niche contained moth orchids, in blue and white. *Phalaenopsis amabilis* was usual in the shows here, but an unusually deep blue *Vanda coerulea* created a sensation. We have had the plant for some ten years, but it seldom blooms at exactly the right date for the orchid show.

"Continuing with the rows of shadow box groups, we came next to a collection of Brassocattleyas, ranging from pure whites through mauve to dark mauve. Most of these are crosses from *Brassocattleya Fournierae* × *C. Trianae,* raised in St. Louis from seed. Lighter shades of mauve are found in the next shadow box group, containing hybrids of *Brassocattleya Fournierae* × *C. Schroederae,* also raised in St. Louis. In this same display was *Oncidium splendidum,* the Tiger Orchid.

"Then came three forms of *Dendrobium nobile,* followed by a group of Botanical orchids, including *Brassavola nodosa* (Lady of the Night), *Laelia Lindleyana, Dendrobium amethystinum* from the Philippines, the Braided Orchid, *Lockhartia pallida,* and also *Oncidium stipitatum,* with its stiletto-like leaves two and a half feet long.

"Next came the jungle scene, flanked on both sides by large niches. These niches displayed collections of various spray orchids, including *Dendrobium superbiens,* with four types of natural hybrids from Australia; *D. bigibbum, Laelia acuminata, L. Gouldiana, L. anceps, L. anceps* brilliant, and hybrids of *D. undulatum* × *D. Phalaenopsis* raised in St. Louis. Varieties of *D. Phalaenopsis* were displayed ranging in color from almost pure white to extremely dark mauve, raised from selected seed strains in St. Louis.

"The so-called jungle scene contained large groups of Cymbidiums and Dendrobiums, both evergreen and deciduous; 3 large *Vanda tricolor* five feet tall; masses of over 300 Cypripediums, including 20 specimens of *C. callosum* and about 100 hybrids such as *C. Arthurianum, C. aureum,* some good *C. actaeus,* etc.

"Orchids and Bromeliads were displayed on trees, the whole picture being framed by *Cibotium Schiedei* and one superb specimen of Anthurium, along with the usual miscellaneous greenery.

"The next group of shadow boxes contained a collection of

Cypripediums, and the fourth niche showed *Laelia anceps* and its pure white forms.

"Another collection of Cypripediums followed in the next shadow box group, including *C. cymatodes beechense superbum,* whose name is more than justified, since it is still an outstanding thing, though we have had it over twenty years. Other lady slippers included *C.* "Olivia," the pink lady slipper; *C.* "Sidney Brown," the yellow lady slipper; the pink flowered *C. Nandii,* and both *C. Holdenii* and *C. Maudiae.*

"It may interest the readers to note that the plants on exhibition were transported from Gray Summit to the Botanical Gardens in St. Louis, a distance of forty miles, during subzero weather in a small heated half-ton truck. The plants were packed in two layers, those from the cooler, higher altitudes next the floor, those from the tropical slopes on a shelf more completely insulated from local temperature conditions. The transportation of the plants during the subzero weather in such excellent condition was a great achievement."

WINTER INJURY

While last winter brought extreme cold weather to gardens in Missouri, it was accompanied by heavy snow. The cold, though severe, was practically continuous so that there was little winter injury due to plants coming into growth too early. Such plants as were seriously damaged were either killed outright by the cold, or were weakened by the dryness which always is an accompanying feature, or by the bright sunlight reflected from the snow. The middle of April is too early to give a complete report; some plants which look seriously damaged now will undoubtedly recover. Others will not reveal the full extent of their injury until much later in the season. Although the conditions were somewhat different, the record of winter injury in 1935-1936 (BULLETIN, vol. 24, p. 130) is interesting as a matter of comparison. No very satisfactory conclusions can be drawn, however, from the record of but two seasons. There does seem to be additional evidence for the statement that plants and trees supplied with water and fertilizer during the growing season are hardier than those not supplied.

WINTER INJURY TO WOODY PLANTS IN THE GARDEN AT ST. LOUIS AND THE ARBORETUM AT GRAY SUMMIT, 1939-40

	1939					
	Flower-buds blasted	*Leaves dehydrated*	*growth killed back to ripened wood*	*Frozen to snow level*	*Killed*	*Remarks*
Abies homolepis		*				
Acanthopanax trifoliatus					*	
Acer carpinifolium					*	
Acer palmatum			*			
Albizzia julibrissin			*			
Amorpha microphylla			*			Slight injury
Berberis Julianae				* or	*	
Brachychiton acerifolium	*					
Broussonetia papyrifera[a]						
Buddleia alternifolia			*			Slight injury
Buxus koreana		*				Moderate sun-scald injury as early as mid-Nov.
Buxus microphylla		*				
Buxus microphylla sinica		*				
Buxus sempervirens		*				
Callicarpa dichotoma				* or	*	
Callicarpa japonica angustata				*		
Callicarpa rubella					*	

[a] Dehydration of bark; injury will not become evident until late summer or autumn.

WINTER INJURY TO WOODY PLANTS—*(Continued)*

	Flower-buds blasted	*Leaves dehydrated*	*1939 growth killed back to ripened wood*	*Frozen to snow level*	*Killed*	*Remarks*
Cedrus atlantica		*				
Cedrus libanotica		*				
Chamaecyparis Lawsoniana		*				
Cornus kousa				*		Uninjured owing to protection
Cornus kousa chinensis				*		Uninjured owing to protection
Cotoneaster Francheti				*		
Cotoneaster horizontalis perpusilla				*		
Cotoneaster tenuipes				*		
Cupressus arizonica					*	
Deutzia scabra "Pride of Rochester"			*			Slight
Elaeagnus "Fruitland"		*				
Evonymus japonica				*		Possibly killed
Evonymus japonica microphylla					*	
Evonymus radicans minima		*				
Forsythia sp.	*					About ½ fl. buds blasted

WINTER INJURY TO WOODY PLANTS—*(Continued)*

	Flower-buds blasted	*Leaves dehy-drated*	*1939 growth killed back to ripened wood*	*Frozen to snow level*	*Killed*	*Remarks*
Hedera helix baltica		*	*			
Ilex cornuta				* or *		
Ilex crenata				*		
Jasminum fruticans				*		
Jasminum nudiflorum				*		
Kerria japonica				*		
Kerria japonica plena				*		
Ligustrum ovalifolium				*		
Liquidambar formosana				*		
Lonicera implexa				*		
Magnolia grandiflora	* or *					Growing in protected locality
Mahonia Aquifolium		*			*	Slight
Mahonia haematocarpa						
Morus alba[a]						
Morus rubra[a]						
Nandina domestica				* or *		
Pinus cembroides	*					Only 2nd-yr. leaves affected

[a] Dehydration of bark; injury will not become evident until late summer or autumn.

WINTER INJURY TO WOODY PLANTS—*(Continued)*

	Flower-buds blasted	*Leaves dehy-drated*	*1939 growth killed back to ripened wood*	*Frozen to snow level*	*Killed*	*Remarks*
Prunus, certain sp.		*	*			
Pterocarya Rehderiana			*			Slight
Pyracantha coccinea Lalandii				*		
Quercus laurifolia				*		
Rhododendron mucronatum		*				
Rhododendron obtusum amoenum		*				
Rhododendron yedoense poukhanense		*	*			
Rosa climbers			*			Except hyb. *Wichuraiana*
Rosa hybrid perpetuals			*			Especially Tausendschön
Rosa hybrid teas				*		
Sapium sebiferum				*		
Spiraea prunifolia plena			*			Slight
Spiraea japonica			*			Slight
Spiraea Thunbergii			*			Slight
Styrax japonica					*	
Taxus baccata adpressa		*				
Taxus baccata fastigiata		*				

WINTER INJURY TO WOODY PLANTS—*(Continued)*

	Flower-buds blasted	*Leaves dehy-drated*	*1939 growth killed back to ripened wood*	*Frozen to snow level*	*Killed*	*Remarks*
Taxus brevifolia		*	*	*		Slight
Taxus cuspidata		*				Slight
Taxus Washingtoni		*				
Teucrium Chamaedrys				*		
Viburnum rhytidophyllum		*				
Viburnum Wrightii				*		

GARDEN CLUB OF ST. LOUIS VISITING DAYS

The Garden Club of St. Louis will again open the gardens of sixteen of its members to visitors on May 18 and 19 from 10:00 a. m. to 6:00 p. m. Last year a very substantial sum was raised by the Club for the "Friends of the Garden Fund." This year it is hoped that an even greater number of garden lovers will welcome the opportunity to view some of the more beautiful gardens in this vicinity and, at the same time, help the Missouri Botanical Garden. The gardens listed include those of:

Mr. and Mrs. Frederick R. Von Windegger, 315 S. McKnight Road
Mr. and Mrs. Royall H. Switzler, 8 Ridgewood Road
Mr. and Mrs. Mortimer P. Burroughs, 700 S. Price Road
Mr. and Mrs. A. Wessel Shapleigh, 23 Fordyce Lane
Mrs. George Mepham, 7 Fordyce Lane
Mr. and Mrs. Archie Lee, 8 Fordyce Lane
Mr. and Mrs. Boyle O. Rodes, 8 Upper Ladue Road
Mrs. Edward Walsh, 9 Upper Ladue Road
Mr. and Mrs. Joseph L. Werner, 9625 Ladue Road
Mr. and Mrs. John V. Janes, 5 Apple Tree Lane
Mr. and Mrs. John S. Lehmann, 10 Apple Tree Lane.
Mr. and Mrs. Chapin S. Newhard, Lindbergh and Ladue Roads

Mr. and Mrs. John K. Wallace, Lindbergh and Ladue Roads
Mr. Peter Seltzer, 302 Leffingwell, Kirkwood
Mr. and Mrs. Hermann von Schrenk, Florissant
Mr. and Mrs. Samuel W. Fordyce, Brown and Hazelwood Roads, Florissant

Tickets are $1.00 for the entire list of gardens. They may be obtained at various florists and department stores as well as from members of the St. Louis Garden Club, and at the Missouri Botanical Garden.

NOTES

Dr. George T. Moore, Director of the Garden, spoke before the Delta Gamma Mothers' Club, April 22, on "Keeping Up-to-Date in the Garden."

Dr. Henry N. Andrews, Instructor in the Shaw School of Botany, broadcast over Station KSD, on April 2, his subject being "Spring Flowers in Missouri."

Mr. Ladislaus Cutak, in charge of Succulents at the Garden, gave an illustrated lecture before the St. Louis Ladies' Florist Club, April 1, on "Cactus Hunting in Texas and Mexico."

The annual flower sermon for which Henry Shaw provided in his will was preached at Christ Church Cathedral, April 28, by the Rt. Rev. William Scarlett, Bishop of Missouri.

Mr. G. H. Pring, Superintendent of the Garden, gave a talk before the Friendly Fellows Club of the Shaw Avenue Methodist Church, March 28, on "Hybrid Tropical Water-lilies."

Mr. Russell J. Seibert, Graduate Student at the Garden, gave an illustrated talk before the Mascoutah Women's Club, Mascoutah, Ill., April 17, entitled "Spring Comes to the Arnold Arboretum."

Mr. Ladislaus Cutak, in charge of Succulents at the Garden, has an illustrated article in the April number of *Desert Plant Life* (**12:** 68–71), entitled "Succulents at the Greater St. Louis Flower and Garden Show."

Mr. G. H. Pring, Superintendent of the Garden, acted as judge of the nature-study exhibitions during the annual "Pow-Wow"

of the Indian Guide Organization at the Webster Groves High School Armory, March 22 and 23.

Mr. A. P. Beilmann, Arboriculturist to the Garden, gave a talk before the University City Parent-Teachers Association, March 12, on "The Tree as a Living Organism"; and before the Columbine Chapter of the Daughters of the American Revolution, April 2, on "Conservation and Thrift of Plant Life."

Mr. Paul A. Kohl, Floriculturist to the Garden, gave an illustrated lecture on "The Missouri Botanical Garden, March 26, before the Hannibal Garden Club, at Hannibal, Mo. On April 2, he gave an illustrated talk on "Roses" before the St. Louis Hills Garden Club.

Mr. George H. Pring, Superintendent of the Garden, as one of the members of the tree-planting committee, spoke at the tree-planting ceremonies at Fairground Park, April 5, when 100,000 soft maple trees were presented to the city and county schools by John S. Swift, of St. Louis.

Dr. George T. Johnson, Research Assistant, and Lecturer in Botany, Henry Shaw School of Botany, has received a John Simon Guggenheim Fellowship to continue his studies of tropical American lichens. He plans to center his work in Cuba, Panama and Costa Rica.

Recent visitors to the Garden include: Dr. A. P. Saunders, professor of chemistry, Hamilton College, Clinton, N. Y., and one of the directors of the American Peony Society; Mr. Paul H. Allen, of Balboa, C. Z., the Garden's Representative in the Tropics; and Miss Bernice G. Schubert, technical assistant and graduate student, Gray Herbarium of Harvard University, Cambridge, Mass.

STATISTICAL INFORMATION FOR MARCH, 1940

GARDEN ATTENDANCE:

Total number of visitors	24,422

PLANT ACCESSIONS:

Total number of plants, seeds and bulbs received as gifts	578

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought	25
Total number of books and pamphlets donated	240

HERBARIUM ACCESSIONS:

By Gift—

Allen, Paul—*Phyllocarpus septentrionalis* Donn. Sm. from Panama	1
Braun, E. Lucy—Plants of Kentucky	3
Bureau of Plant Industry, U. S. Department of Agriculture—Apocynaceae and Asclepiadaceae from Costa Rica and Mexico	17
Cutler, Hugh C.—Plants of New Mexico, Arizona, and Utah	13
Hancin, John—*Salix nigra* L. from Kansas	1
Penland, C. W.—Plants of Ecuador	3
Questel, Adrien—Plants of Guadeloupe	11
Ragonese, A. E.—Plants of Argentina	30
Scully, F. J.—Plants of Arkansas	16
Seibert, R. J.—Specimens and illustrations of Bignoniaceae	2
Seibert, R. J.—Plants of Florida	175
von Schrenk, Hermann—*Pinus sylvestris* L. from Missouri	1

By Exchange—

Clokey, Ira W.—Plants of California and Nevada	333
University of Pennsylvania by John M. Fogg, Jr.—Plants of Virginia	215

By Field Work—

Woodson, R. E., Jr.—Plants of Panama	18
Total	839

STAFF
OF THE MISSOURI BOTANICAL GARDEN

THE GARDEN, 2315 TOWER GROVE AVENUE, ST. LOUIS, MISSOURI

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NOTICE

ATTENTION is called to the recently issued "Spring Flora of Missouri" by J. A. Steyermark. About 1,400 plants blooming in Missouri and adjoining states before June 1 are described and most of them illustrated. Designed primarily for nature-lovers, scouts, amateur botanists, etc., emphasis is placed on the common name; also, an attempt is made to write the descriptions in simple untechnical language so that, with the help of the keys and the illustrations, identification of spring-blooming flowers should not be difficult. The book is cloth-bound and comprises 590 pages, 163 plates, and 444 line drawings. For sale by the Missouri Botanical Garden. Price $3.00.

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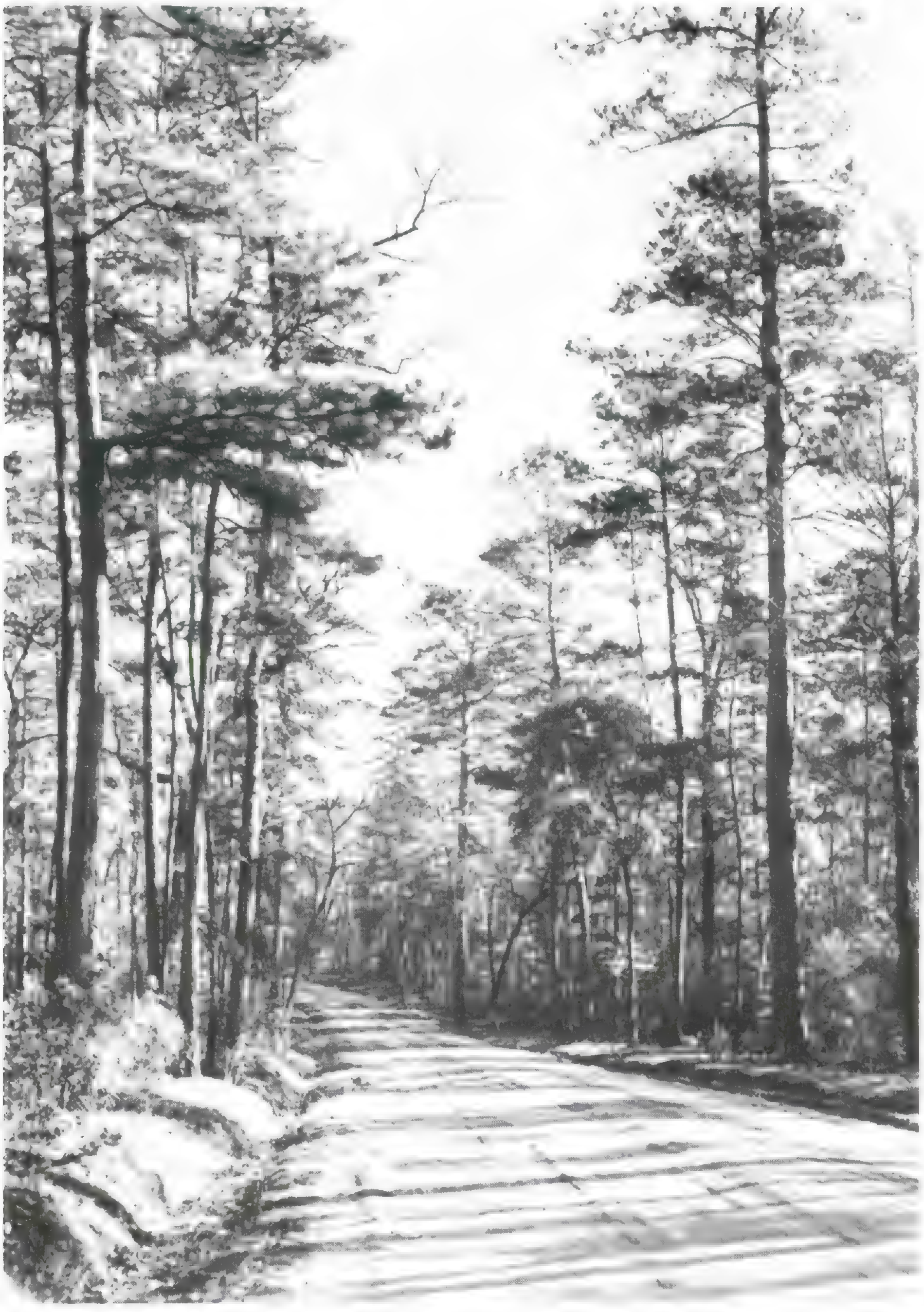
SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date to the death of Mr. Shaw, in 1889, the Garden was maintained under the personal direction of its founder, and while virtually a private garden it was, except at certain stated times, always open to the public. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was designated by Mr. Shaw as its official title and in his will and all of his writings he specifically referred to it as the "Missouri Botanical Garden." By a provision of Mr. Shaw's will the Garden passed at his death into the hands of a Board of Trustees. The original members of the Board were designated in the will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will, the immediate direction of the Garden is vested in a Director, appointed by the Board of Trustees. The Garden receives no income from city or state, but is supported entirely from funds left by the founder.

The city Garden comprises 75 acres, where about 12,000 species of plants are growing. There is now in process of development a tract of land of over 1,600 acres outside the city limits which is to be devoted to (1) the propagation and growing of plants, trees, and shrubs, designed for showing either indoors or outside, at the city Garden, thus avoiding the existing difficulties of growing plants in the city atmosphere; (2) gradually establishing an arboretum as well as holding a certain area as a wild-flower reservation, with the idea that possibly at some future time this may become the new botanical garden.

The Garden is open to the public every day in the year except New Year's Day and Christmas—week days from 8:00 a. m. until sunset; Sundays from 10:00 a. m. until sunset. The greenhouses are closed every day at 5:00 p. m.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Place, on the Sarah car line (No. 42). Transfer south from all intersecting lines.



PINE FOREST IN THE BIG THICKET, TEXAS

Missouri Botanical Garden Bulletin

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SCOUTING THE SHORT-LEAF PINE

Missouri, unlike many states, cannot boast of a varied coniferous flora. There are but three true conifers within the state. The most commonly distributed is the juniper (*Juniperus virginiana* L. and *J. mexicana* Spreng.), most frequently called cedar. The much more majestic cypress (*Taxodium distichum* Rich.) is known from only a few counties within the ancient embayment, south and southwest of Cape Girardeau. While this tree is technically a conifer it is also deciduous and therefore not very imposing during the winter—the period when evergreens enliven the landscape. The third conifer is the short-leaf pine (*Pinus echinata* Mill.) which agrees with our notion of how an evergreen should look and grow. However, it seems never to have penetrated much farther north in Missouri than a point some forty miles south of Gray Summit. Although many attempts have been made to establish a group in the plantings at the Arboretum, so far it has never become more than a transient. It seems that other factors—in addition to climate—are responsible for some of these failures.

Gardeners are well aware that plants are often reluctant to establish themselves even a few miles beyond their natural range, unless every soil, moisture, exposure and climatic requirement has been met. The difficulty usually is in determining what the requirements are and applying the knowledge before the struggling plant dies. Often the needed information can be obtained only by a study of the plant in its natural surroundings, and this became the purpose of a trip covering a considerable portion of the range of *Pinus echinata* during December, 1938.

Although the log of the trip includes many references to wholly unrelated trees and shrubs, the various associations often hold a

clue to the climatic requirements of a species. Certainly the preferred soil types are indicated, leaving little doubt concerning a tolerance for acid or neutral soils. A condensation of the log, covering 2,700 miles of travel through six southern states, while following a single tree species from its northern to its southern range, is presented here. It is not often that most of the geographic range of a species can be covered so quickly, nor that so many individuals can be found for study.

Following U. S. Highway No. 67 south, the short-leaf pine makes its first appearance just south of Fredericktown, Missouri. From here until near Poplar Bluff it is an active competitor of the hardwoods over many of the hillsides. Near the town of Marquand, pine logging has been carried on for many years. Below Poplar Bluff the flora changes to one typical of drained swamp land and this continues as far as Little Rock, Arkansas. Although much of the region is given over to cotton farming, at one time it contained a magnificent stand of hardwoods. A remnant of such a forest can be seen in the Big Oak State Park at East Prairie, Missouri.

Somewhat south of Little Rock the swamp flora gives way suddenly—on slightly higher ground—to that associated with pine, and here is one of the few places where pine and cypress grow within fifty feet of each other. It was also interesting to observe that the sweet gum (*Liquidambar Styraciflua* L.), so successfully used as a shade tree in St. Louis, could leave the swamp and become a competitor of the pine on the higher ground. The adaptability of the sweet gum, its vigor and aggressiveness, are really remarkable. The holly (*Ilex opaca* Ait.) can be found with the pine, usually in the wetter places.

Two species of pine are found in the pine belt of Arkansas, the short-leaf and the loblolly (*Pinus Taeda* L.), and there is some evidence that they hybridize. At least, there is a third pine, a very vigorous tree, rather difficult to identify, sometimes resembling short-leaf and sometimes loblolly pine. While scouting for seed it was observed that the short-leaf produced the greatest number of cones, loblolly far less, and the presumed hybrid almost none. Both species of pine are at "home" in this region; both are sufficiently aggressive to restock an abandoned field, yet they do not reforest a "burn" or a bare logging site until huckleberry has

become established. The soil under a tangle of huckleberry (*Vaccinium arboreum* Marsh.) is usually very acid, and this may be an important requirement—aside from protection—for seedlings, or for the mycorrhiza always found with the pines. The probable role and importance of the mycorrhiza will be discussed later.

Within the town limits of Malvern, Arkansas, seeds were collected from an old and well-established hedge of wild lemon (*Poncirus trifoliata* Raf.). After dodging the spines while photographing the plant and collecting the seed, there was no doubt in our mind that a wild lemon hedge is a "cattle tight" fence.

The Osage orange (*Maclura pomifera* Nutt.), as noted in the BULLETIN of April, 1938, grows in pure stands only in the Red River Valley of East Texas. A tree of such general interest to the gardener and of such importance to the aboriginal tribes was well worth the day-long drive necessary to collect and photograph it. The largest stands are within Bowie and Red River counties and are rapidly being cut to make more land available for farming. The mistletoe (*Phoradendron flavescens* Nutt.) attacks every hardwood within the vicinity, and the Osage orange—notably free of enemies—is no exception. Normally this tree grows only in the black alluvial soil of the river valley, the red soils of the slopes supporting both species of pine and the *Sabal Palmetto*.

From New Boston, Texas, southward, is a stretch of country very reminiscent of portions of Missouri, in that old fields and fence rows are dotted with groups of sassafras—an uncommon tree since leaving that state. Near Black Cypress Bayou, a projection of the Louisiana lowland, some cypress and Spanish moss were seen. Beyond, the country is more rolling and pines again appear.

Just outside the city limits of Nacogdoches, Texas, short-leaf pines were found growing to a height of 110 feet with trunks measuring 28 inches in diameter. On the banks of the Angelina River the overcup oak (*Quercus lyrata* Walt.) grew equally as tall and much larger in diameter. A specimen of this oak growing in the Garden has not exceeded 25 feet in 40 years. The water oak (*Quercus nigra* L.) attains the same stature as the overcup oak in East Texas, but specimens in the Garden appear never to grow larger. While both species have proven entirely winter-hardy in St. Louis they fail to flourish as they do 600 miles farther south.

The Big Thicket in East Texas is an immense tract which retains much of its primeval character. The town of Livingston is at the western edge and Woodville is the present eastern edge. While much logging has been done in the Big Thicket, time, the great aid of Nature, has healed many of the scars and one can travel for days in this pine forest covering 1,000,000 acres. The abrupt change from the usual farm land, after leaving Livingston, to the deep forest of the Big Thicket is breath-taking. To measure and photograph a bull bay (*Magnolia grandiflora* L.) 79½ feet high and eight feet in circumference is to express better than words what has been lost through ill-advised land clearing which at best yields only another form of sub-marginal agriculture. Both the short-leaf and the loblolly pines reach their climax in this region. The growth rate is remarkable and the regeneration more than ample to maintain the species as the dominant tree. In the very sandy soils there is little competition from other species of forest trees. To anyone familiar with the beeches of the eastern states, those of the Big Thicket—festooned with Spanish moss—would seem quite bizarre. The sweet bay (*Magnolia virginiana* L.) is rather uncommon in parts of the region but is abundant near the Neeches River. However, cultivated specimens often surpass these wild plants in symmetry and profusion of bloom. The youpon (*Ilex vomitoria* Ait.) is browsed by deer and cattle, and the continued cutting of the more succulent tips produces a very symmetrical and sometimes formal shrub. The plants growing in a small "bay gall," an acid bog or swale and part of the surface drainage system, should be of interest to many gardeners. The following list, including only mature plants, was made within a radius of fifty feet of a little bridge near Swab City, Texas:

Azalea nudiflorum
Ilex opaca
Ilex vomitoria
Fagus grandifolia
Ostrya virginiana
Vaccinium arboreum
Cephalanthus occidentalis
Pinus Taeda
Magnolia grandiflora
Magnolia virginiana
Persea borbonia
Quercus alba
Quercus nigra
Quercus rubra

A program to preserve some of this area is the purpose of the East Texas Big Thicket Association. To its president, Mr. R. E. Jackson, are due many thanks for the opportunity of examining this tract. Thanks are also due Mr. J. R. Keig, Mr. L. J. Fischer,

and Mr. P. A. Winkler, for their many courtesies during a tour of several hundred miles through the Big Thicket. Fifty short-leaf pine seedlings, the gift of Mr. Balthis of Kirbyville, were potted and continued their growth during the summer of 1939. If they withstand the cold of this January they will be moved to Gray Summit for planting in the Pinetum.

The pines are not found in the coastal plain of Louisiana. They reappear north of Lake Pontchartrain, where the spruce pine (*Pinus glabra*) replaces the short-leaf pine. As one continues north into Mississippi the loess bluffs support magnolias, beech, holly, as well as various oaks and some loblolly pine, but the impressive pine forests of eastern Texas are not duplicated near the highway.

Mycorrhiza was found on the roots of the pine seedlings obtained from Mr. Balthis, and it has been present in the potted plants ever since. Roots of pine examined in Arkansas and Texas were infected, but the frozen soil and lateness of the season made the collection of infected roots in Missouri rather uncertain. The mycorrhiza of a tree root is a fungus which replaces the root tip with an absorbing organ much more capable of extracting food from an infertile soil. The success or failure of many tree plantings may be due in part to the absence of this fungus which enters into a symbiotic association with the tree roots. Hatch[1] has shown, through the use of soil free of mycorrhiza, that pine seedlings are incapable of absorbing mineral salts from infertile soils. Mitchell,[2] working with nursery stock, has confirmed this work. Trees may succeed on very fertile soils without the mycorrhiza, but they cannot grow on poor soils without it, and one might suspect that the mycorrhiza becomes increasingly important to trees planted farther and farther beyond their natural range.

A. P. B.

MONARCH OF THE CACTUS HOUSE FALLS

The much battle-scarred veteran of the Cactus House is reduced to a mere skeleton of itself. For nearly twenty-five years, or ever since the present desert house was established, it reigned supreme

[1] Hatch, A. B. Black Rock Forest Bull. 1937.
[2] Mitchell, H. L. Black Rock Forest Paper. 1937.

in the collection. By no means was it the tallest cactus but it was a behemoth in all other respects. Branching from near the base it had sent up huge, wide-spreading succulent arms, while the central trunk rose fifteen feet above the ground. It had come to the Garden in 1898, but beyond that no data is available. It was probably nearly fifty years old.

Greenhouse plants are much slower growers than those planted in the open ground, and under California and Texas skies this species would have required only about twenty years to reach a height of fifteen feet. Our plant would have been more massive were it not that numerous joints had to be cut off frequently in order to keep prospective initial carvers at a distance. This specimen, as well as many others, suffered great abuses in 1931 and 1932, so much so that it was decided to close the Cactus House until the wave of depredation had abated. Beside the perpetrations of initial carvers, umbrella pokers, souvenir hounds and reasonless visitors, our plant was also badly damaged by falling glass during the memorable hailstorm of May, 1927.

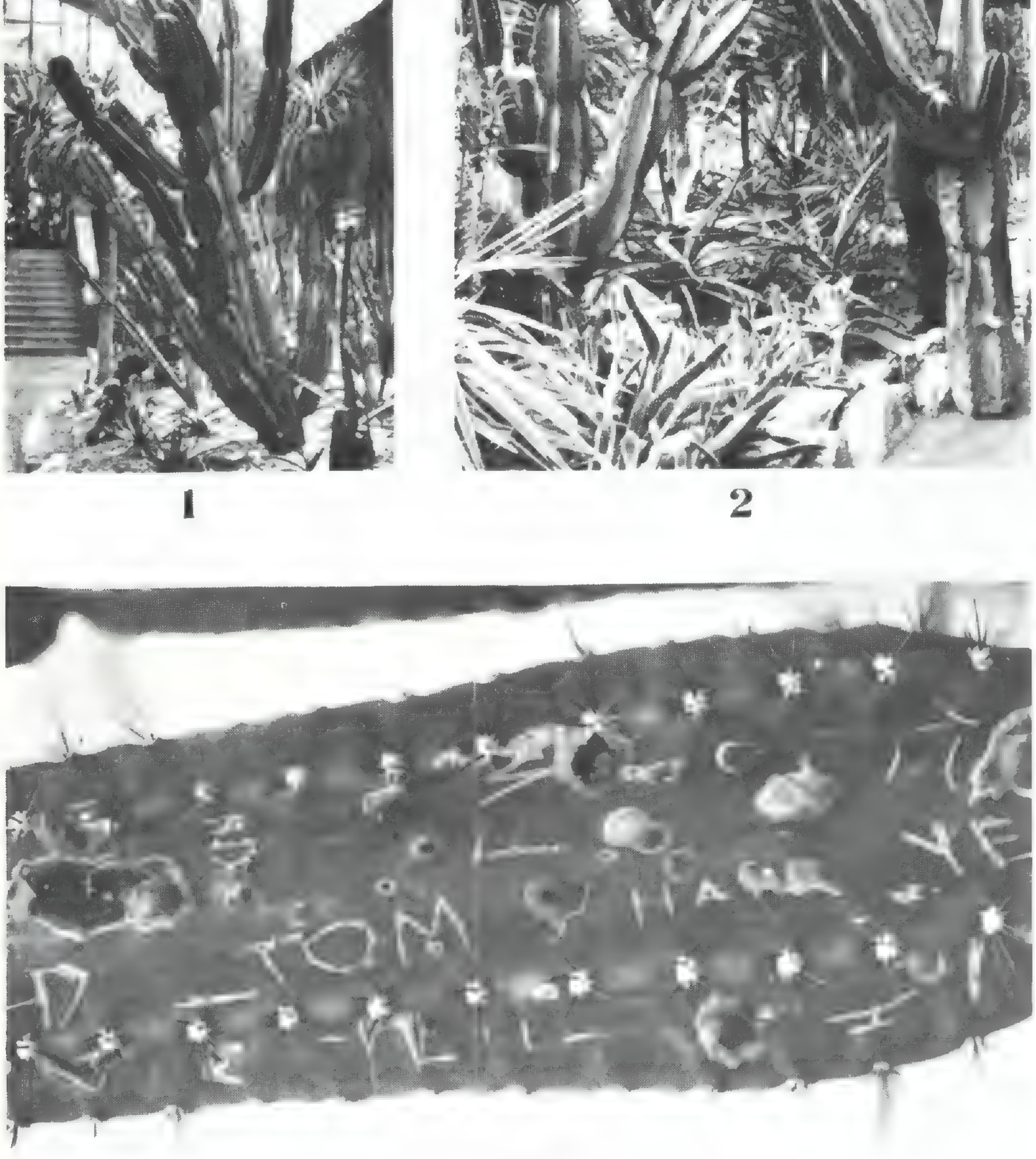
On April 19, this once proud monarch collapsed in a heap—a victim of top-heaviness. Fortunately, only one plant growing in the immediate vicinity was damaged, a highly prized, five-foot *Cephalocereus polylophus* being decapitated by the falling mass. Outside of being reduced considerably in size, which of course is greatly lamented, the heavily branched "King of the Shaw's Garden cacti" escaped with negligible injuries. Two or three long, many-armed stems were salvaged, almost intact, and these will be allowed to callus before being placed in sandy soil to encourage root growth. Although shorn of its former magnificence, this cactus still will command attention.

Plants of this species have existed for a long time, usually parading as *Cereus Jamacaru* or under some other name. When Dr. Werdermann, of Berlin, visited the Huntington Botanic Garden in California a few years ago, he found a specimen which seemed to warrant a distinct name. After careful study, he decided that it should be known as *Cereus grandicostatus,* which literally means "the large-ribbed torch or candle cactus." A description of this species, growing in the Garden collection, is given here as an aid to its identification:

Generally it is an upright, very robust grower with extremely

1

2



3

"THE MONARCH" *(Cereus grandicostatus)*

1. As it looked in 1931. 2. After the fall. 3. Initial-scarred infected joint.

heavy limbs, the oldest stems averaging eight to ten inches in diameter. A very short trunk, less than twelve inches in length, is noticeable. The branches arise terminally, as well as laterally, and in great profusion. The young growth is of a striking bluish color, caused by a thin coating of wax which can be rubbed off very easily. This glaucous covering is characteristic of many cacti and is extremely typical of our plant. As the stems mature they lose their azure color and take on a greenish hue, finally becoming gray and scaly in old age. Gazing upon the drab epidermal coat of the trunk and oldest branches, it isn't difficult to compare it with the thick, wrinkled hide of an elephant.

The young branches are deeply six-ribbed, but five and seven ribs are not uncommon. The ribs are rounded at the ridge and three-eighths inch wide at that point, also more or less undulate, the large prominent areoles appearing in the scallops. The areoles are at least three-eighths inch in width and slightly less than one to two inches apart. These organs are filled with gray-brown felt and white cobwebby hairs and some reddish-brown spines of variable lengths, but all under five-sixteenths inch. On older stems, the web-like hairs disappear and the felt assumes a grey-white cast, until in the very old stems it appears as a densely packed, circular, slightly raised cushion. The spines in these areoles usually fall off, only the knob-like bases persisting in a semi-lunar fashion in the lower portion. The spines, averaging thirteen to sixteen for each areole, gradually change in color, becoming nearly black with age, and occupying the lower two-thirds portion of the areole.

L. C.

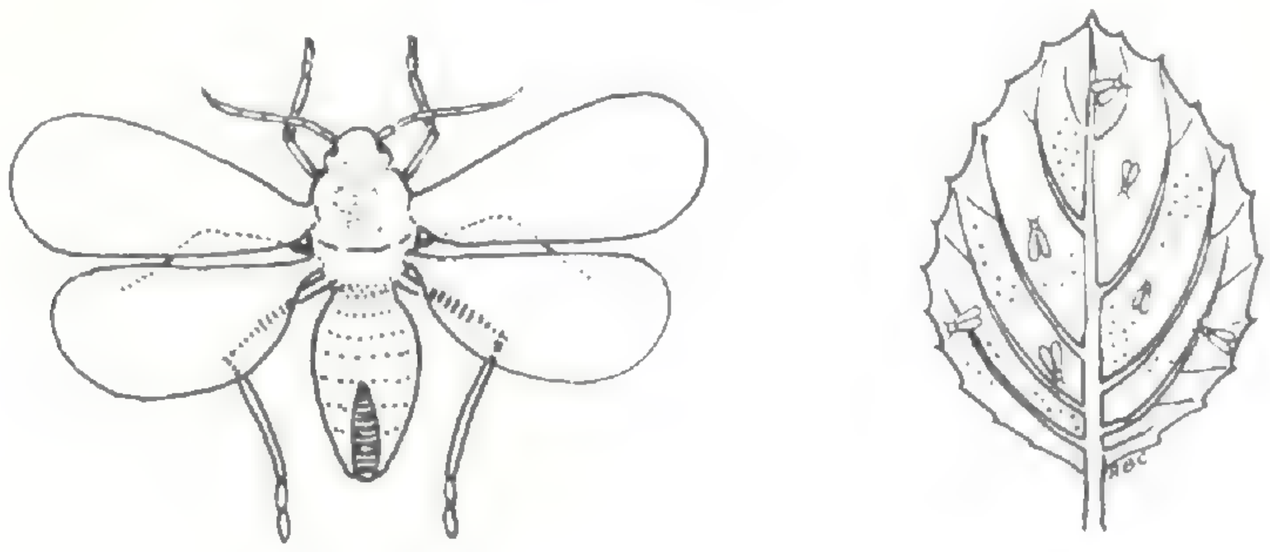
IDENTIFICATION AND CONTROL OF COMMON PLANT PESTS

PLANT PEST NO. 4—WHITE-FLIES

Certain kinds of house plants are very susceptible to white-flies whereas others seem to be partly or completely immune to their depredations. The plants which they prefer most are fuchsia, lantana, ageratum, begonia, coleus, calendula, salvia, penstemon and geranium (especially the scented varieties). White-flies are tiny, pure white, harmless-looking parasites and are generally found on

the under-sides of the leaves. The adults are very active and fly off in all directions when disturbed, thus making control by sprays, dips and washing rather doubtful at times. The insect increases by means of eggs which are deposited in large numbers on the under-sides of the leaves. These eggs are quite inconspicuous and resistant to insecticides. They hatch in about two weeks and the young gradually develop into adult flies which immediately start laying eggs for another generation.

White-flies are sucking insects and injure plants by extracting the juices from the leaves and stems. Infested plants turn yellow, wilt, and finally die if these pests are not checked. The larvae and pupae excrete a sticky substance that accumulates dust and encourages the growth of a sooty fungus.



A B

A, adult white-fly (x15); B, White-flies and eggs on under side of leaf (nat. size).

The most effective control for white-flies is fumigation with cyanide, but this is an extremely lethal gas and should be used only by those who know and appreciate its deadly properties. The recommended dosage is one-fourth ounce to 1,000 cubic feet of space, the treatment to be repeated at two-week intervals until the infestation is cleaned up. Spraying the under-sides of the leaves with nicotine (one teaspoonful to a quart of water) and soap solution helps matters somewhat, but it is not a sure cure. Washing the adult flies and eggs off the plants with soapy water is a simple method which is most successful when the temperature is cool (45-60° F.), because then the insects do not fly away as readily as they do when it is warm. Perhaps the best idea is to adopt precautionary tactics and never bring plants into the house unless you are sure that they are free of all harmful insects. D. C. F.

NOTES FROM THE MISSOURI BOTANICAL GARDEN ARBORETUM

Under this heading it is planned to publish from time to time random observations of general interest which are too short or too trivial for separate treatment.

NARCISSI DURING 1940.—As in previous years the narcissi were in bloom for almost exactly two months, but the entire season was delayed a full two weeks so that they blossomed from the middle of March to the middle of May rather than from late February to the last of April. The height of the season came during the week of April 14 when nearly half of the collection was in full bloom. Many of the varieties provided an attractive display in spite of severe freezing weather with snow and sleet. "February Gold" came into flower the last week in March at the same time as the old-fashioned yellow trumpets. It is certainly one of the best if not *the* best daffodil for early-season display in Missouri. Many of the more expensive new varieties are not to be recommended for mass display in such a climate as ours. "Gallipoli" and "Mytelene," for instance, have flowers too large for their stems and are knocked down by the wind, particularly when they are weighted with snow or rain. Some, such as "King Alfred," tend to "run out" when planted in the grass and left to themselves. Many of the newest and largest have such large flowers that they are unsightly in the landscape after they have gone out of flower. In contrast to all of these, the old reliable variety "Emperor" has stems which remain erect through wind and rain and although so floriferous as to make a showy mass of soft yellow in the landscape, the withering flowers are noticeable for only a day or two. It has the longest blooming season of any of the yellow trumpets at Gray Summit and was attractive this year from the first of April until about the twentieth.

Of the newer and more expensive varieties "Beersheba" continued to give a very good account of itself. The disproportionately short stems, which are often considered a defect, are a positive advantage in the Missouri climate and its large clear white flowers remained erect through two snowstorms and one heavy rain. The last of the collection to bloom was the old-fashioned

variety "Recurvus." Though old and cheap, this is one of the best varieties for mass planting. It differs from the other poet narcissi by the way in which its white perianth is curved or rolled backwards and by the heavy substance of its flowers which consequently make a fine display in the landscape and continue in bloom in spite of hot sun and dry winds.

DUCKS IN THE PINETUM.—Every spring sees a larger number of waterfowl using the artificial ponds in the Arboretum during migration. The small reservoir in the Pinetum is deep enough so that it attracts a number of species which are seldom seen on such a small body of water. Ring-neck ducks arrived the last week in February and were seen more or less continuously until late in March. On March 17 over fifty individuals of this species were counted at one time, together with a few lesser scaup, a pair of mallards, four pintail, and a few coot.

COLOR VARIETIES OF *Mertensia virginica*.—In addition to the change from pink to blue, which is seen in most inflorescences of Mertensia and which is variously affected by soil differences and by the temperature, there are several marked variations in color to be found in the Ozarks. Pure whites are rare but a number have been reported. These show no vestiges of either pink or blue in the buds or in the fully opened flowers. A much commoner variation is frequent at Gray Summit and has been noted at other points near by. In this form the flowers are lavender rather than pink in the bud, and open to a soft gray-blue, rather than the brilliant blue of the typical Mertensia. At times they have a rather washed-out look and after several sunny days they may fade to a gray-white. In a large planting of Mertensia they add variety to the color and though they are themselves less brilliant they make the other plants seem brighter by contrast. In a perennial border they might be used to give a particular effect since they make a most attractive combination with yellow tulips. Last spring several plants of this color-form were staked when in flower and were moved to a new location during the summer after their leaves had died down. They all blossomed well this spring and showed the same characteristics in their new location that they had in the old. E. A.

NOTES

Mr. George H. Pring, Superintendent of the Garden, broadcast over Station KWK, May 20, on "What to Plant in the Garden."

Mr. A. P. Beilmann, Arboriculturist to the Garden, has a paper on "Frost Cracks," in the February number of *Shade Tree* (Vol. 13, No. 2).

Dr. George T. Moore, Director of the Garden, has been appointed Honorary Counselor of the 1940 California Spring Garden Show, Berkeley, Calif.

Dr. Harry J. Fuller, assistant professor of botany, University of Illinois, Urbana, brought his class in economic botany to visit the Garden on May 10.

Dr. Edgar Anderson, Geneticist to the Garden, acted as judge at the annual flower show of the Associated Garden Clubs of Kirkwood, on May 16.

The April number of the *Cactus and Succulent Journal* (**12**: 66-70. 1940) contains an article by Mr. Ladislaus Cutak, in Charge of Succulents at the Garden, entitled "Beyond the Beaten Path."

Dr. William B. Drew, Assistant Professor of Botany, and Dr. Louis C. Wheeler, Instructor in Botany, University of Missouri, brought a group of twenty students, May 18, to study the outdoor plantings in the Garden greenhouse collections.

Mr. Ladislaus Cutak, in Charge of Succulents at the Garden, gave an illustrated lecture, "Camera Clicks in Old Mexico," before the St. Louis Camera Club, May 15, and before the Holy Name Society of St. Boniface Church, May 16.

Dr. Hugh C. Cutler has been appointed research fellow in the Henry Shaw School of Botany and is collaborating with Dr. Anderson in a monographic study of *Tripsacum*. During the coming summer he will be botanist on the Norman Nevills expedition down the Green and Colorado Rivers.

The April number of the ANNALS OF THE MISSOURI BOTANICAL GARDEN (Vol. 27, no. 2) contains two papers by Dr. Mary Maxine Larisey, formerly Instructor in the Henry Shaw School of Bot-

any: "Monograph of the Genus Baptisia," and "A Revision of the North American Species of the Genus Thermopsis."

Mr. George H. Pring, Superintendent of the Garden, gave a talk before the Belleville Woman's Club, April 29, on "Henry Shaw and His Garden"; and before the Scottish Rite Club, May 1, on "The Romance of Plant Life." On May 2 he presented films showing "Four Seasons in the Missouri Botanical Garden," before the Floriculture Club of the University of Illinois, Urbana.

The following, from the Garden or the Shaw School of Botany, were recently elected to the Society of Sigma Xi at Washington University: full members—Dr. David H. Fairburn, Horticulturist to the Garden; Mr. Ralph E. Rawlings, Assistant in the Shaw School of Botany, Elizabeth Jeanette Heuser, Assistant in the Shaw School of Botany, and Robert W. Schery, graduate apprentice at the Garden.

Recent visitors to the Garden include: Dr. Henry A. Moe, Secretary John Simon Guggenheim Foundation, New York; Dr. Julian A. Steyermark, Assistant Curator of the Herbarium, Field Museum of Natural History, Chicago; Dr. S. J. Record, Dean of the Yale School of Forestry, New Haven, Conn.; Miss Bernice Schubert, Technical Assistant, Gray Herbarium of Harvard University, Cambridge, Mass.

The May *Bulletin of the Torrey Botanical Club* contains a symposium on "The Concept of the Genus," the second part (**67:** 363-369) being a discussion by Dr. Edgar Anderson, Geneticist to the Garden, on "A Survey of Modern Opinion"; and the third part (**67:** 371-374) by Dr. J. M. Greenman, Taxonomist to the Garden, on "Genera from the Standpoint of Morphology."

STATISTICAL INFORMATION FOR APRIL, 1940

Garden Attendance:

Total number of visitors	20,661

Plant Accessions:

Total number of plants and seed packets received as gifts	1,683

Library Accessions:

Total number of books and pamphlets bought	32
Total number of books and pamphlets donated	182

HERBARIUM ACCESSIONS:

By Purchase—	
Cooke, William Bridge —"Mycobiota of North America"	70
Edwards, Mary Taylor—Plants of Mexico	603
Field Museum of Natural History—Photographs of type specimens of *Krameria*, *Bumelia*, and Bignoniaceae	522
By Gift—	
Clark, Robert—Plants of Illinois	7
Clark, Robert —Plants of horticulture	2
Cutler, Hugh C.—Plants of Oklahoma	8
Epling, Carl C.—Illustrations of *Salvia*	94
Greenman, J. M.—Plants of Illinois	22
Hubricht, Leslie—Plants of Illinois	33
James, Leslie—Plants of Alabama	14
Lodewyks, Maude C.—*Forestiera acuminata* Poir. from Illinois	1
Seibert, Russell J.—Plants of Florida	158
Seibert, Russell J.—Plants of horticulture	4
Smith, A. C.—Plants of Bolivia	43
U. S. National Herbarium Plants of Colombia	2
By Exchange—	
Field Museum of Natural History—Photographs of type specimens of Asclepiadaceae	366
University of Kentucky by F. T. McFarland Plants of Kentucky	200
Total	2,149

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NOTICE

ATTENTION is called to the recently issued "Spring Flora of Missouri" by J. A. Steyermark. About fourteen hundred plants blooming in Missouri and adjoining states are described and most of them illustrated. Designed primarily for nature-lovers, scouts, amateur botanists, etc., emphasis is placed on the common name; also, an attempt is made to write the descriptions in simple untechnical language so that, with the help of the keys and the illustrations, identification of spring-blooming flowers should not be difficult. The book is cloth-bound and comprises 590 pages, 163 plates, and 444 line drawings. For sale by the Missouri Botanical Garden. Price $3.00.

MISSOURI BOTANICAL GARDEN BULLETIN

Vol. XXVIII JUNE, 1940 No. 6

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SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date to the death of Mr. Shaw, in 1889, the Garden was maintained under the personal direction of its founder, and while virtually a private garden it was, except at certain stated times, always open to the public. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was designated by Mr. Shaw as its official title and in his will and all of his writings he specifically referred to it as the "Missouri Botanical Garden." By a provision of Mr. Shaw's will the Garden passed at his death into the hands of a Board of Trustees. The original members of the Board were designated in the will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will, the immediate direction of the Garden is vested in a Director, appointed by the Board of Trustees. The Garden receives no income from city or state, but is supported entirely from funds left by the founder.

The city Garden comprises 75 acres, where about 12,000 species of plants are growing. There is now in process of development a tract of land of over 1,600 acres outside the city limits which is to be devoted to (1) the propagation and growing of plants, trees, and shrubs, designed for showing either indoors or outside, at the city Garden, thus avoiding the existing difficulties of growing plants in the city atmosphere; (2) gradually establishing an arboretum as well as holding a certain area as a wild-flower reservation, with the idea that possibly at some future time this may become the new botanical garden.

The Garden is open to the public every day in the year except New Year's Day and Christmas—week days from 8:00 a. m. until sunset; Sundays from 10:00 a. m. until sunset. The greenhouses are closed every day at 5:00 p. m.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Place, on the Sarah car line (No. 42). Transfer south from all intersecting lines.

1
AVENUE OF BALD CYPRESS, TOWER GROVE PARK, ST. LOUIS

2
GROUP OF BALD CYPRESS AT ALFRED AVENUE ENTRANCE OF THE GARDEN

Missouri Botanical Garden Bulletin

Vol. XXVIII JUNE, 1940 No. 6

THE BALD CYPRESS AS A SHADE TREE

The bald cypress *(Taxodium distichum)* was featured in the December, 1932, issue of the BULLETIN where it was called "The Most Interesting Tree in Missouri," and at other times it has been the subject of short articles. Some six years ago seed germination and later growth tests were begun, and the information thus gathered seems worthy of attention.

The bald cypress is one of only three conifers—and the only deciduous one—growing in Missouri. It is of a very ancient race of trees. Fragments found in the Far North and identified by paleobotanists indicate that it was once very common and of wide distribution. Some evidence indicates that it might have been the dominant tree some eons ago when the polar regions were much warmer. Seemingly the advancing cold and the glaciers gradually forced it farther and farther south. During these migrations the family became separated and developed what we recognize as three genera to-day: Sequoia (the redwoods) of the west coast, Glyptostrobus of the Chinese rice paddies, and Taxodium (the cypress) of the Mississippi Valley and the Gulf Coast. In its travels over half the western hemisphere the cypress has outdistanced and outlived most of its enemies. To-day we find it relatively free of disease and not often attacked by insects.

Aside from its botanical interest the bald cypress has played a very important part in the economics of the Mississippi Valley. As structural timber the wood is famous for resistance to decay when submerged, and the logging operations in the Delta country have furnished a livelihood for several generations. To-day the land once occupied by forests of cypress has been drained and given

over to cotton farming, and only a few isolated stands in inaccessible places remain to indicate the grandeur of this tree.

Some of the finest specimens of bald cypress to be found anywhere are growing in the Garden and in Tower Grove Park, many of which were planted by Mr. Shaw. As an ornamental shade tree it has few equals. It is perhaps the most adaptable North American tree. We find it growing to maturity in the deep well-drained soil within the city limits, and it does well in the shallower soils at Gray Summit. It grows in the dry arroyo near San Antonio, Texas, and the writer once saw a specimen within sight of the state capitol in Albany, New York. In short, it thrives and can attain maturity in any locality east of the Rockies where the rainfall is about 30 inches, and as far north as the Great Lakes. A tree so well adapted to a wide variety of soils, so economical in its use of water, so resistant to disease and equally repugnant to insects should be more frequently planted as a shade tree.

Usually the potentially "perfect" shade tree presents some peculiar propagation problem, otherwise it would be easily obtainable and not too expensive. In the case of the bald cypress—which is grown from seed—the chief difficulty seems to be in obtaining seed, and secondly obtaining seed which germinates well and produces a vigorous plant.

Since it was known that all cypress seed, especially those from the North, did not germinate well, some attempts were made in 1934 to locate seed yielding a high percentage of plants with sufficient vigor to carry them through the critical first and second years. For this work seeds have been obtained from the following localities: *Missouri:* Florissant, St. Louis; *Arkansas:* Marianna, Marked Tree; *Alabama:* Livingston, Monroe County, Escambia County; *North Carolina:* Laurinburg, Columbus County; *Louisiana:* Lake Charles, Donner; *Texas:* Kerrville, Comfort, San Antonio, Waring; *Florida:* Barton, Palatka, Sebring, Olustee; *Mississippi:* Hollandale; *Tennessee:* Reelfoot Lake.

When possible a thousand seeds were obtained for germinating each year. They were collected in the fall and winter, and stored at room temperature in paper bags and boxes. In the spring they were sorted and counted and the obviously sterile and imperfect seeds discarded. Planting was done in temporary cold-frames—sometimes 50 feet long—to facilitate planting, counting, irriga-

Source	*Number seeds planted*	*Number germinated*	*Per cent germinated*
Florissant, Mo.	160	5	3.1
Marked Tree, Ark.	100	17	17
Columbus Co., N. C.	400	37	9.2
Columbus Co., N. C.	600	71	8.5
Palatka, Fla.	1,000	24	2.4
Barton, Fla.	400	9	2.4
Monroe Co., Ala.	1,000	12	1.2
Escambia Co., Ala.	800	45	5.6
Covington Co., Ala.	1,000	50	5
Donner, La.	400	48	12
Lake Charles, La.	1,000	77	7.7
Comfort, Tex.	1,000	58	5.8
Center Point, Tex.	1,000	1	0.1
Kerrville, Tex.	717	6	0.8
Polk Co., Fla.	300	96	32

tion and weeding. Small cypress must be protected from the midday sun by lath shades.

Transplanting cypress is difficult because even small seedlings have a tap-root considerably longer than the top is high. Therefore every nursery procedure should be directed toward producing a fibrous root system. Cypress which have stood in the nursery row for several years have a root system reaching downward as far as rock, hard pan or the water table, and become very difficult to transplant. Annual transplanting of nursery stock is essential, and even then many secondary roots will be found growing straight down. One can plant cypress as a shade tree with the assurance that its roots will effectively anchor it against any wind. No one has ever seen a cypress uprooted by wind or washed out and carried away by flood water.

Of course germination of the seeds is but a small part of the problem. When planting a cypress one is much more concerned about the possibility of growing it to maturity. If there are physiological races of cypress, then it follows that there will also be some marked differences in the adaptability and growth rate of the seedlings. A hasty glance at a nursery row of such plants shows striking differences in habit as well as rate of growth. It may be said that the cypress seed collected from trees growing near their northern limits are inferior in most respects. Those

from Louisiana and Texas are superior in rate of growth and ability to stand transplanting. The Texas trees are the farthest west outpost of Taxodium and are separated from other cypress by several hundred miles of country not suited for Taxodium. The West Texas types are distinct; they grow very rapidly, germinate well and are so resinous that rabbits, usually very fond of young cypress, leave them alone. Seed collected in Louisiana germinate well and produce a fast-growing very symmetrical plant entirely suitable for shade-tree use. There is some objection to northern seed; the germination percentage is rather low and becomes lower as one goes north, and usually the seedlings are more difficult to transplant. All types have proven hardy regardless of their origin; those from San Antonio planted at Gray Summit have not been injured by cold. A. P. B.

A NEW PYGMY WATER-LILY

(Nymphaea colorata)

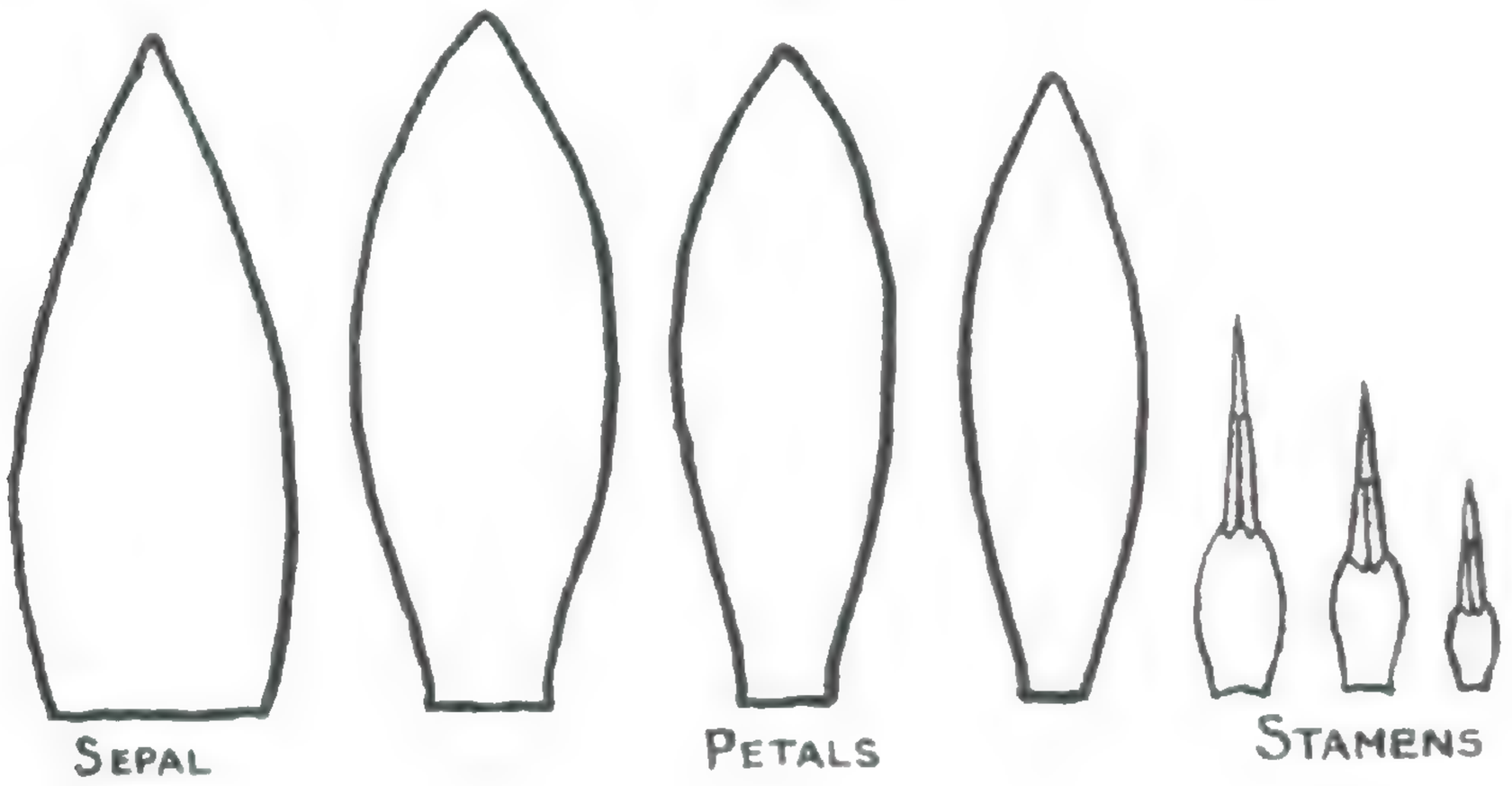
The seeds of this pygmy water-lily were received from Africa by the Royal Botanic Gardens, Kew, England, and from there they were sent to the Garden by Mr. R. S. Trickett, in March, 1938. Immediately on arrival they were sown in the greenhouse propagating tanks, and the resulting four plants were planted later in the outside pools. When the first flowers opened in July the plant immediately suggested itself as a very charming subject for small garden pools. The color of the petals is an attractive blue-violet. The stamens are originally purple, but on the second day the bases turn bright yellow which is enhanced by the normal reflexing of the outer whorls. The anthers, which are at first purple, turn decidedly reddish, with the tips blue. The sepals are white, flecked with light blue.

When grown in the greenhouse the plants produce only single crowns, resulting in fewer and larger flowers. However, grown outside under more normal conditions, three or four crowns soon develop laterally from the original vertical tuber. During August, upwards of one hundred leaves measuring from four to six inches across will radiate from the center of the plant. When young, the under-sides of the leaves are purple, but with age they turn dark

A NEW PYGMY WATER LILY (*Nymphaea colorata*)

brown with green venation. The petioles also change in color, from light green to brownish-green. The number of flowers open at one time will vary from eight to ten, sometimes twelve, on a plant.

Two new water-lilies were described in 1928 by A. Peter ("Wasserpflanzen und sumpfgewächse in Deutsch-Ostafrika," in Ges. d. Wiss. z. Göttingen, math.-phys. Kl. Abhandl. n.f. **13**[2]: 1–128), under the names *Nymphaea colorata* and *N. polychroma*. At first it was a question in which species to place the four plants raised at the Garden, and the following season thirty plants were grown as a check for variability. After careful study, the key dif



Nymphaea colorata (natural size).

ference between the two species was found in the horizontal rhizomes of *N. polychroma*. Young plants flowering in the greenhouse answered to the description of *N. colorata* whereas those grown outside to either *N. colorata* or *N. polychroma*. The following description is from fully developed plants observed at the Garden, growing both in the greenhouse and in the outside pools during August. The color terms are according to Ridgway's "Color Standards and Color Nomenclature."

Flowers 3–4 inches across, 8 10 opening at one time, bud ovoid, light green; sepals lanceolate-acuminate, 1½ inches long, ½ inch wide, light green suffused with blue towards the apex, 8–10 nerves (5–6 in the greenhouse plants); petals 14–16 (10–

12 in the greenhouse) in two rows, pale violet fading with age, light yellow at the base; stamens 90–95 (36–38 in the greenhouse), litho-purple, lighter towards the apex; appendages primrose-yellow, outermost row 1 inch long, innermost ½ inch long; carpels 18–20 (in the greenhouse 12–14) with primrose-yellow styles; stigmatic surface more or less flat; fruit subglobose, 1 inch in diameter, containing many fertile seeds; mature leaves suborbicular-sagittate, irregularly undulate-sinuate, about 6 inches in diameter, lobes overlapping one-third from the center, above dark green, below purple turning greenish-brown (in the greenhouse the purple does not change); mature plants bearing 100 leaves radiating from community crowns; rootstock erect, branching laterally within four weeks after planting outside, and producing nests of 8-12 small nut-like tubers in September, these soon drying up during winter storage. G. H. P.

IDENTIFICATION AND CONTROL OF COMMON PLANT PESTS

PLANT PEST NO. 5—SCALE INSECTS

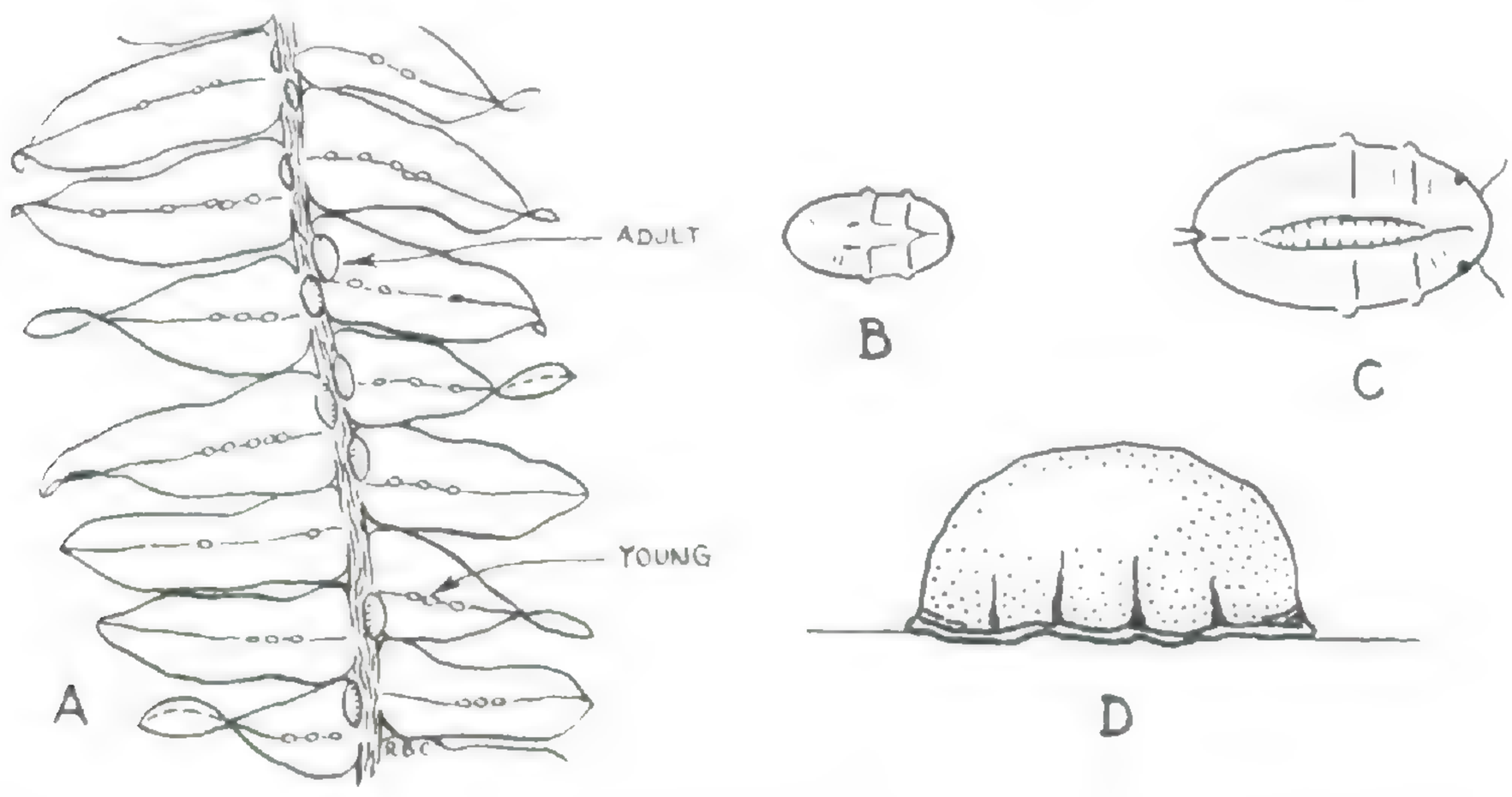
Certain kinds of house plants such as ferns, palms, oleanders, ivies, rubber plants and orchids are subject to attack by various types of scale insects. Injury by scale progresses slowly compared to that by aphids, mealy bugs, red spiders and white-flies, but the results are usually serious. These insects suck the vital cell sap out of the leaves and stems, causing the host plant to turn yellow and lose its normal vigor.

Scale insects, for the most part, are rather inconspicuous and may become well established before detected. They come in a number of different shapes, sizes and colors. Some are round and flat, others have a convex surface, and there are pear-shaped as well as hemispherical varieties. They range from the size of a pin point up to about that of a kernel of wheat. The colors are yellow, brown, red or greenish-black. The males are often white. Like turtles, the insects hide under a protective shell or scale where they can feed and multiply in comparative safety. The females do little moving around. The males have wings and are

more active, but do not injure the plants as much as the females. Eggs or living young are produced under the mother scales, and the youngsters soon crawl away to establish themselves in new quarters.

Scale on ferns should not be confused with spore cases on the under-sides of the leaves. These cases contain spores which are on the order of seeds and used to propagate the ferns. They occur in definite patterns on the leaves whereas scale is scattered irregularly on the stems and leaves.

Plants badly infested with scale generally are not worth saving. The pests may be hard to destroy and the plants too weak to re-



Scale insects: A, on fern leaf (× ½); B, young stage (× 25); C, mature stage (× 8); D, old stage (× 5).

cuperate. If only a few leaves are heavily infested, they can be cut off and burned. Syringing the plants with water under pressure is sometimes effective. Ferns may be dipped in a pail containing 40 per cent nicotine sulphate (at the rate of one ounce to three gallons of water with three ounces of laundry soap added), or if too large to dip they can be sprayed with this same solution. In either case they should be rinsed with clear water about two hours afterward. Continue the treatment at weekly intervals until the pests disappear. Palms and oleanders may be sprayed with miscible oil or fish-oil soap, but do not use this with ferns or orchids in flower. Nicotine also discolors flowers. D. C. F.

COLCHICINE TO AID THE PLANT BREEDER

The work of plant breeders up to date has been remarkable in the production of more useful and varied plants from the stocks available. As these stocks are limited and becoming widely exploited by hybridizers, a new development is obviously needed if progress is to continue at its present rate. An introduction that promises fair to become an important aid to the plant breeder is the chemical, colchicine.

This chemical, a complex narcotic similar to morphine and codeine, is found in the roots of *Colchicum autumnale*, the meadow-saffron. It is a very potent and very poisonous substance whose immediate effect on growing tissue is to produce stunting and distortion. Until recently, colchicine has been used only in the medical profession as a remedy for gout.

In normal plants the cells pull apart when they divide. The effect of colchicine on the individual plant cells is to cause a doubling of the chromosomes by more or less drugging the mechanism. Chromosomes are the minute units in any cell of an organism that make it what it is, and each plant has a definite group of chromosomes different from that of other plants. By doubling the number of these units in each cell the plant is changed, but not radically, so that it still resembles its original self yet is usually improved.

From the above discussion one can see that this chemical must be applied to growing tissue so that it may act upon cells which are in the process of dividing. Colchicine treatment may be given by spraying or injecting the plants with the solution or immersing them in it.

In spraying the plants care must be taken to keep the solution from the soil. The resulting roughening or crumpling of the leaves is caused by the unequal growth of the cells under the new conditions. From the affected areas a new type of growth emerges if the treatment has not been too severe. This new growth is similar in appearance to that of the original plant, yet it should produce rather different flowers and fruits. Applying the chemical in a lanolin paste is a neat and effective way of producing the same effect.

Injecting growing plants with solutions is practiced with some

varieties but many plants do not react well to this treatment. Moreover, as injection is rather difficult this method is seldom used.

Soaking seeds or young seedlings in colchicine solutions is the best method of producing doubled chromosomes, for when a seed is affected the resulting plant is completely of the new type of tissue; whereas, when a plant is sprayed, only certain portions of the plant are altered. The main difficulty is to obtain seeds with enough tissue affected so that a new type of stem will be produced, yet not so severely affected that the root fails to develop.

Colchicine is a water-soluble chemical obtainable at most druggists or from chemical concerns; its solutions are unaffected by light or by standing and the same solution may be used repeatedly. Concentrations used may range from 0.01 to 0.8 per cent with those below 0.2 per cent giving more consistent results. Immersions may last from six hours to ten days, depending upon the plant treated. There has been too little work done to date with this chemical to give the optimum concentration and length of treatment for more than a very few plants. A little experimenting, however, soon indicates the optimum for the plant you happen to be working with.

The ultimate effect of chromosome doubling is the production of larger, more vigorous plants bearing larger flowers and fruits but resembling those of the original untreated plants. The production of an increased size of flowers is the most useful end to be attained because most fruits thus produced are of an inferior grade. Other effects predicted by some breeders from the use of this chemical, but not yet attained, are the changing of annuals to perennials, increased disease resistance, and the production of hybrids between rather widely separated species of plants.

STANLEY BETTONEY.

NOTES FROM THE MISSOURI BOTANICAL GARDEN ARBORETUM

ALTERNATE FLOWERING OF *Echinacea pallida*.—For six years the purple cone flowers on the glades in the wild-flower garden have flowered heavily every other year. In the odd-numbered

years, 1935, 1937, and 1939, there have been so many blooms that they showed in the distance as a patch of rose-purple. In the even-numbered years, 1936, 1938, and 1940, flowers were so few that one had to hunt to find them and two or more were seldom found near together. It seems probable therefore that the purple cone flower, like many other plants (as, for instance, some varieties of apples), tends to flower heavily in alternate years.

THE PURPLE ROCKET, *Iodanthus pinnatifidus*.—For a short time in late May and early June the purple rocket is one of the daintiest and loveliest of our native wild flowers. Growing in damp and shady spots in flood-plain woodlands it is seldom noticed even by people interested in wild flowers because it blooms after the Mertensias and other early spring flowers have gone to seed and the woods are dank and "mosquitoey." The flowers are a very pale rosy-purple, almost white, and are borne in long delicate racemes. If it proves easy to grow from seed it may perhaps make an attractive flower for shady perennial borders. E. A.

NOTES

Dr. David C. Fairburn, Horticulturist to the Garden, gave a talk before the St. Clair Garden Club, Belleville, Ill., June 4, on "Garden Soil."

Mr. A. B. Beilmann, Arboriculturist to the Garden, gave an illustrated talk, June 3, before the Building Officials Conference of America, on "The Tree as a Living Organism."

Mr. Ladislaus Cutak, in charge of succulents at the Garden, gave an illustrated lecture, "Camera Clicks in Old Mexico," June 21, before the Married Men's Sodality of St. Anthony Church.

Mr. Paul A. Kohl, Floriculturist to the Garden, showed two reels of colored motion pictures depicting "Spring and Summer in the Missouri Botanical Garden," before the Neighborhood Association, May 16.

Mr. George H. Pring, Superintendent of the Garden, gave the graduating address at the Lindenwood Public School, June 11. On June 13 he spoke to the Optimists Club of Granite City, Ill., on "The Romance of Plant Life."

Mr. Russell J. Seibert, graduate student at the Garden, spoke at a meeting of the North St. Louis Real Estate Salesmen's Association, June 5, on "Panama." His talk was illustrated with natural-color slides.

Mr. L. P. Jensen, Manager of the Garden Arboretum, gave a talk before the Bourbouse Council, Boy Scouts of America, at Union, Mo., April 16, on "Nature Study and the Scout"; and before the Garden gardening classes, May 10, on "Recent Activities in the Development of the Arboretum."

The number of schools from a distance which come to the Garden is constantly increasing. During the month of May over 1,600 pupils from schools or colleges in Missouri, Illinois, Indiana and Oklahoma visited the Garden, the majority arriving in chartered buses. The largest representation was from Sedalia, Missouri, with 600 in the party.

The seventh annual convention of the Missouri State Federation of Garden Clubs was opened on the morning of May 23 at the Arboretum, with the Sullivan Garden Club as hostess. More than 300 ladies registered at the Gateway Lodge, after which they were conducted through the grounds, visiting the pinetum, one of the trails in the wild garden, and the orchid houses. In spite of the incomplete condition of the roads and bridges and much of the planting, a good idea of the future possibilities of the Arboretum was obtained.

Recent visitors to the Garden library include: Prof. O. S. Aamodt, of the U. S. Dept. Agr., Washington, D. C.; Dr. Catharine Lieneman, assistant professor of botany, Wisconsin State Teachers College, River Falls; Mr. C. J. Gould, instructor in botany, Iowa State College, Ames; Dr. Harold Morrison, of the bureau of entomology and plant quarantine, U. S. Dept. Agr., Washington, D. C.; the Hon. George D. Aiken, Governor of Vermont and an authority on horticultural subjects; Dr. Julian F. Smith, Associate Director Hooker Scientific Library, Central College, Fayette, Mo.; Mr. H. A. Stevenson, of the U. S. Soil Conservation Service, Elsberry, Mo.; Dr. George J. Goodman, assistant professor of botany, Iowa State College, Ames.

The following articles by members of the Garden staff and students have recently appeared in gardening or botanical publications: "The Gladiolus in St. Louis Gardens," in the June number of *Garden Life* (**13:** 45-46), "Ridding the Garden of Moles," reprinted from Garden BULLETIN, in the June *Garden Digest* (**12:** 53-54), by Dr. David C. Fairburn; "The White Pygmy Water-Lily," by Mr. G. H. Pring, in the June *Flower Grower* (**27:** 274); "Shading New Transplants with Brush," by Dr. Edgar Anderson, in *Real Gardening* (**3:** 20-21.); "Suggestions to Clubs on Roadside Development," in the March number of *Garden Forum* (**2:** 11), by Mr. L. P. Jensen; "The Chromosome Complement of *Bumelia lanuginosa*," by Mr. William L. Brown and Mr. Robert B. Clark, in the April *American Journal of Botany* (**27:** 237-238).

STATISTICAL INFORMATION FOR MAY, 1940

GARDEN ATTENDANCE:

Total number of visitors	42,255

PLANT ACCESSIONS:

Total number of plants and seed packets received as gifts	873

LIBRARY ACCESSIONS:

Total number of books bought	15
Total number of books and pamphlets donated	84

HERBARIUM ACCESSIONS:

By Gift—

Ammerman, Elizabeth—Plants of Texas	60
Anderson, E.—Plants of central United States	12
Andrews, Henry N. Jr., and George T. Johnson—Plants of the southern United States	173
Bailey, L. H.—*Astianthus viminalis* (HBK.) Baill. from Mexico	1
Beilmann, A. P.—Plants of horticulture	2
Henson, Dorothy—Plants of Oklahoma	5
Hubricht, Leslie—Plants of Illinois	6
Massey, A. B.—Plants of Virginia	2
Parks, H. B.—Plants of Texas	8
Peebles, R. H.—Plants of Arizona	11
Seibert, Russell J.—Plants of Florida and of horticulture	74
Seibert, Russell J.—Photographs of types and authentic specimens of Bignoniaceae	37
Stitt, L. L.—Plants of Arizona	6
von Schrenk, Hermann—Plants of Texas	115
von Schrenk, Hermann—Plants of horticulture	2

By Exchange—	
Bureau of Plant Industry U. S. Department of Agriculture—Plants of western United States and Mexico.....	1,470
Field Museum of Natural History—Photographs of type specimens of Marantaceae and Zingiberaceae.....	150
Field Museum of Natural History—Plants of Costa Rica....	643
Gray Herbarium, Harvard University—Plants of North and South Carolina....	949
State College of Washington Plants of northwestern United States	149
By Field Work—	
Woodson, Robert E., Jr.—Plants of Panama, estimated at ..	3,500
Total....	7,375

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NOTICE

ATTENTION is called to the recently issued "Spring Flora of Missouri" by J. A. Steyermark. About fourteen hundred plants blooming in Missouri and adjoining states are described and most of them illustrated. Designed primarily for nature-lovers, scouts, amateur botanists, etc., emphasis is placed on the common name; also, an attempt is made to write the descriptions in simple untechnical language so that, with the help of the keys and the illustrations, identification of spring-blooming flowers should not be difficult. The book is cloth-bound and comprises 590 pages, 163 plates, and 444 line drawings. For sale by the Missouri Botanical Garden. Price $3.00.

MISSOURI BOTANICAL GARDEN BULLETIN

Vol. XXVIII SEPTEMBER, 1940 No. 7

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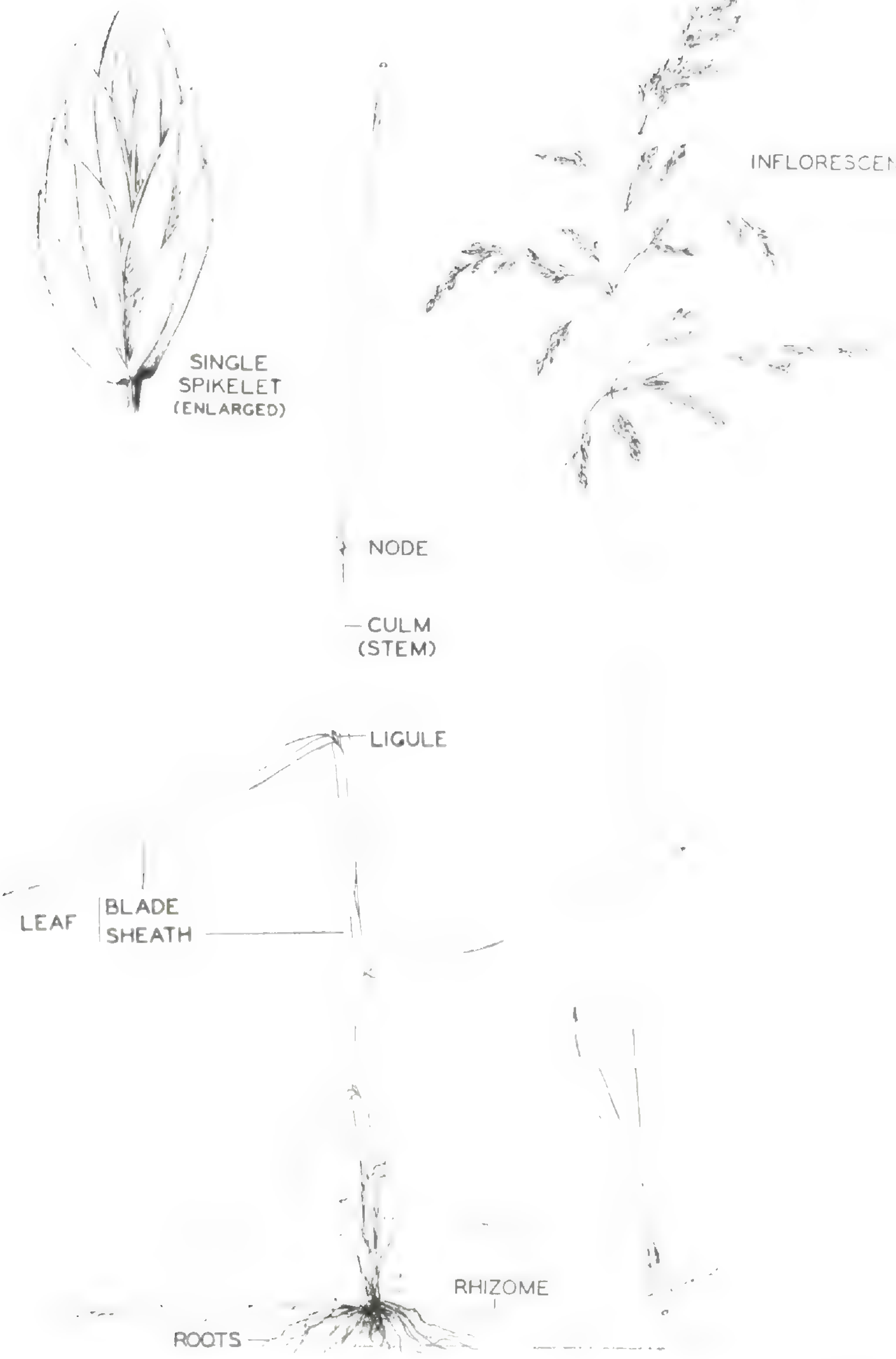
SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date to the death of Mr. Shaw, in 1889, the Garden was maintained under the personal direction of its founder, and while virtually a private garden it was, except at certain stated times, always open to the public. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was designated by Mr. Shaw as its official title and in his will and all of his writings he specifically referred to it as the "Missouri Botanical Garden." By a provision of Mr. Shaw's will the Garden passed at his death into the hands of a Board of Trustees. The original members of the Board were designated in the will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provison of the will, the immediate direction of the Garden is vested in a Director, appointed by the Board of Trustees. The Garden receives no income from city or state, but is supported entirely from funds left by the founder.

The city Garden comprises 75 acres, where about 12,000 species of plants are growing. There is now in process of development a tract of land of over 1,600 acres outside the city limits which is to be devoted to (1) the propagation and growing of plants, trees, and shrubs, designed for showing either indoors or outside, at the city Garden, thus avoiding the existing difficulties of growing plants in the city atmosphere; (2) gradually establishing an arboretum as well as holding a certain area as a wild-flower reservation, with the idea that possibly at some future time this may become the new botanical garden.

The Garden is open to the public every day in the year except New Year's Day and Christmas—week days from 8:00 a. m. until sunset; Sundays from 10:00 a. m. until sunset. The greenhouses are closed every day at 5:00 p. m.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Place, on the Sarah car line (No. 42). Transfer south from all intersecting lines.



KENTUCKY BLUE GRASS, WIDE LEAVED STRAIN, SHOWING THE VARIOUS PARTS OF THE PLANT

Missouri Botanical Garden Bulletin

Vol. XXVIII SEPTEMBER, 1940 No. 7

LAWNS AND LAWN GRASSES FOR ST. LOUIS

INTRODUCTION—THE LAWN GRASS PROBLEM

Considering the fact that almost every St. Louisan grows a little grass, if he grows anything at all, it is surprising how little accurate information there is on the subject. Any local gardener who is interested in dahlias or irises or peonies can find excellent books about these plants and can fairly easily get in touch with people who make a specialty of them and know their particular needs in this difficult climate. But if a St. Louis gardener wants a good lawn there has been practically no one he could turn to. To supply this lack, the Missouri Botanical Garden began, three years ago, a comprehensive study of the lawn problem in this area. That study is being continued and will be continued until the problem is solved as nearly as possible.

The following account is a summary of some of the more important facts which have been found out in these three years. By themselves they will not enable all St. Louisans to have good lawns, but they will make it possible for any intelligent gardener to grow a better lawn than before or to grow a lawn with less effort. Take, for example, the matter of spring raking. It is recommended by the books and by many professional gardeners. But the books were written in the North and East, and many of the gardeners received their training in that area where blue grass, properly cared for, makes a lush heavy turf. It is true that, under such conditions, raking out the old grass in the early spring improves the lawn, or at least does it no harm. But in St. Louis the old dead grass, nine times out of ten, is not blue grass but

crab grass, a very different kind of plant which dies each fall with the first heavy frost and starts from seed late the following spring. Raking it out does not remove the seeds; it merely helps to plant them all the better. Worse than that, unless it is very carefully done, raking may dig out a good deal of blue grass. It would naturally seem, then, that in St. Louis the best thing for the average gardener who is not actually rebuilding his lawn would be to leave the dead crab grass as a kind of natural mulch. For three years a small grass plot at the Missouri Botanical Garden has been raked every spring on the west side and left unraked on the east. At the beginning of the experiment the two halves of turf were essentially alike. Each year has seen the unraked half appear just a little better until now the balance is distinctly in its favor. Experiments on a few lawns in South St. Louis have given similar results. It is our preliminary conclusion, therefore, that in metropolitan St. Louis, spring raking does no good to the lawn and may actually make it worse instead of better.

One simple fact leads to the misinformation about lawns of which the above is a typical example and makes the study of lawns a special problem. Let us print it in capital letters for its importance cannot be over-emphasized: NEARLY ALL GRASSES LOOK ALIKE. The average successful lawn, which makes a carpet of green from early spring until late fall, is a mixture of different kinds of grasses and is as complex in its entirety as a perennial border. It is a battleground where competing grasses advance and retreat and form new alliances to advance again. If blue grass were really blue and redtop were red, and if all our other grasses had each its distinctive color, we would understand how the make-up of a lawn changes from season to season and from year to year. We would see the crab grass advance with the onset of hot weather, watch the Kentucky blue grass spring into new life in the fall, and understand the role of annual blue grass in early spring.

Anyone who has managed a perennial border successfully knows that it cannot be treated as a whole. The irises must be grown as irises, the peonies treated as peonies, and the Korean chrysanthemums given the proper care for Korean chrysanthemums. If they were all treated alike the perennial border would

soon be a sorry mess. That is essentially what is wrong with St. Louis lawns. They are being considered merely as if they were just grass. Not until a considerable number of real gardeners in this area have learned to distinguish our main lawn grasses and have learned by experience how these very different lawn materials react under various combinations of soils and changing seasons will we be able to manage our lawns as intelligently as we do the rest of our gardens.

GRASSES AND WEEDS OF ST. LOUIS LAWNS

As we have found to our sorrow, it is no easy matter to learn to distinguish the grasses growing in an average lawn. Books on the subject are of little or no help. Specialists on the identification of grasses have been too busy to go into details about the common every-day appearance of ordinary lawn grass. Faced with the gigantic task of cataloguing the world's grasses, they have contented themselves with precise keys and descriptions for grasses which have grown up and gone to seed. Consequently, if one wished to identify the materials in his lawn and to do it accurately he would, like us, have had to let selected bits of lawn go to seed in order to use the books on the subject.

Having spent several years in learning just what grasses are growing in St. Louis anyway, we have tried to write descriptions of them as they grow in the lawn and to provide illustrations showing them in that condition. All lawn grasses tend to look very much alike, and no gardener is going to be able to identify them by reading our descriptions and looking at the accompanying diagrams. But if he will study them in his lawn throughout a season we believe that our discussion will enable him to understand, at the end of the season, what grasses are there and what they are doing.

Blue Grasses.—Three blue grasses are commonly found in St. Louis: Kentucky blue grass, Canada blue grass, and annual blue grass; and from our preliminary trials it would seem that our native woods blue grass, *Poa sylvestris* (fig. 4), might also find a place here. All of these species tend to be a darkish green and to start into growth very early in the spring, commonly by the first week in March. Like most blue grasses, they have a distine-

tive leaf tip, which is often referred to as boat-shaped (fig. 1B). "Boat-shaped" is perhaps not the best word unless one is thinking of the prow of a viking ship. If the prow of a boat had a shape like the tip of a blade of redtop it might float on a quiet mill pond but it would not cut through the waves effectively on a stormy sea. It is easy, however, to imagine a seaworthy boat shaped in front very much like the tip of a blue-grass leaf, which

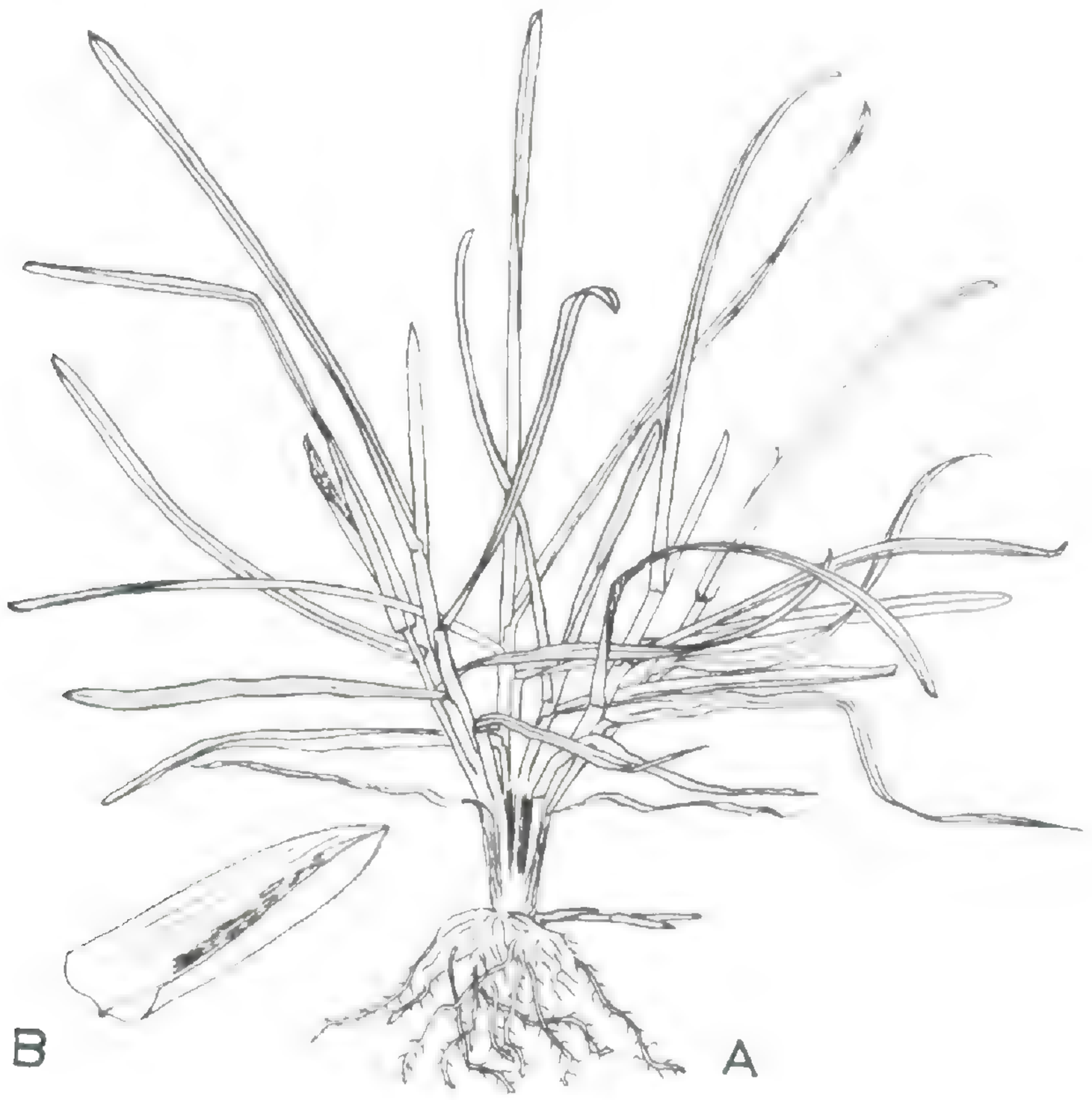


Fig. 1. Kentucky blue grass, *Poa pratensis*. A, habit (× ½); B, leaf tip (× 2).

would cut through the water without letting in the waves. The distinctive shape can sometimes be felt when the grass blade is pulled between the thumb and forefinger, even though it may be too small to distinguish with the naked eye; and with a little experience this is probably the easiest means of recognizing the blue grasses. The early spring growth and the boat-shape tip will distinguish the blue grasses as a whole, but to tell the various blue grasses apart we shall have to study other details.

KENTUCKY BLUE GRASS *(Poa pratensis)*.—If Kentucky blue grass were a well-behaved species and varied no more than do silver maples, for instance, it would be easy to write a precise description of it. Unfortunately, it is one of the most variable species in our flora. When we first began to study the grasses in the lawns of St. Louis several of those which seemed distinct turned out to be just another variation of *Poa pratensis*, for it is an intricate complex of species, subspecies, races, varieties, and forms. In a lawn the variation in leaf width is the most conspicuous difference, and a gardener who sets out to study Kentucky blue grass should expect to find some strains of the species with the widest grass leaves in his lawn and others with the narrowest.

Kentucky blue grass, by the way, is not really blue, and only at certain times of year and in certain situations does it even have a bluish cast to the foliage. The easiest way to recognize it in the field is by the bunched way in which it grows. If a small sample is pulled up from the lawn and gently teased apart into its smallest units it will be found that the leaves and stems do not arise singly, but are in tight little bunches, like vegetables which have been tied up for the market. In an old, well-established sod the withered remains of last year's leaves will be conspicuous at the base of each little bunch. Kentucky blue grass may also have long under-ground runners which creep out and give rise to new bunches of leaves and stems (note pl. 8).

This growth habit is characteristic of Kentucky blue grass and can be used to diagnose the species at any time of the year. In general aspect, however, it goes through a series of changes with the season. It is the second of our grasses to begin growth in the spring, following closely after the annual blue grass, *Poa annua*. It first shows as richly dark green leaves among the dead remains of last year's turf. While it looks something like annual blue grass at this stage, the leaves are darker green and harder and wirier. For the first week or so they stay close to the ground and do not build up rapidly into little mats as do those of the annual blue grass. As the season advances there is usually a sudden burst of activity, and the Kentucky blue grass shoots up to a height of six inches or more. In some years it seems as if it had appeared over night and a healthy blue grass lawn becomes almost a meadow in

the course of a few days. In early May it starts to flower, producing a profusely branched tassel-like top, and at this stage is popularly referred to as "June Grass." If it is not mowed the tassel has a bluish or purplish cast which gives an interesting play of color to meadows, pastures, and roadsides. With the onset of real hot weather in late May or June, the grass appears to die down very quickly. It does not really die (if it is in good health) for it is one of those intelligent plants which have learned to lie dormant or semi-dormant through the scorching heat of a St. Louis summer. Unless the summer is unusually cool and moist, or unless the lawn is watered intelligently, it remains throughout the summer as a dry, wiry, bluish-green turf, the leaves more or less browned and singed-looking, until September brings cool nights again. Then it starts into growth, slowly if the autumn is a dry one, rapidly if there is moisture, and by the first heavy frost it is again a carpet of green, and remains so until the ground freezes.

ANNUAL BLUE GRASS (*Poa annua*).—To one who knows Kentucky blue grass, *Poa annua* could be described as being much lower, much earlier and annual rather than perennial. It is the first grass in St. Louis to green up in the spring, in most years showing color by the first week in March. The plant begins as a chunky little rosette, with leaves much like those of Kentucky Blue grass, but shorter, lighter-colored, and much more succulent (fig. 2). In sunny lawns it is rather rare and will be found only along a walk, or next to buildings, but in shady situations it may carpet the ground solidly over several square yards. Long before the other blue grasses have even thought of flowering, its tiny, green tassels appear among the leaves and (unlike the other blue grasses) continue to bloom even if the lawn is closely clipped. The plant is so low, however, that its flowering may pass unnoticed, for even when mature it is seldom over three or four inches high and in a lawn it is often much shorter. It reaches the height of its flowering season in late April, and from then until the end of May it becomes progressively yellower and more dried-up until at the onset of hot weather it disappears completely. By this time its seeds have been sown, and they remain dormant through the summer and autumn and germinate during the winter.

CANADA BLUE GRASS (*Poa compressa*).—Canada blue grass is the only one of the three blue grasses which is really blue. Compared to Kentucky blue grass it is a bluer green at all times of the year, somewhat smaller, much more slender, and more stemmy and less leafy (fig. 3). When pulled up out of the lawn or pasture it looks

Fig. 2. Annual blue grass, *Poa annua* (× ½).

much like Kentucky blue grass but has longer runners and the flowering stems arise singly rather than in little bunches. In the early spring its flattened stem is characteristic, though this is less noticeable as the season advances. At this time of year the stem and leaf bases are often shaded with dark red, and the combination of blue-green and dark red in the turf is one of the most

noticeable early spring differences between it and Kentucky blue grass. Canada blue grass flowers a little later than Kentucky blue grass and does not dry up so much during the hot weather. The flowering tassel is smaller and is proportionately narrower.

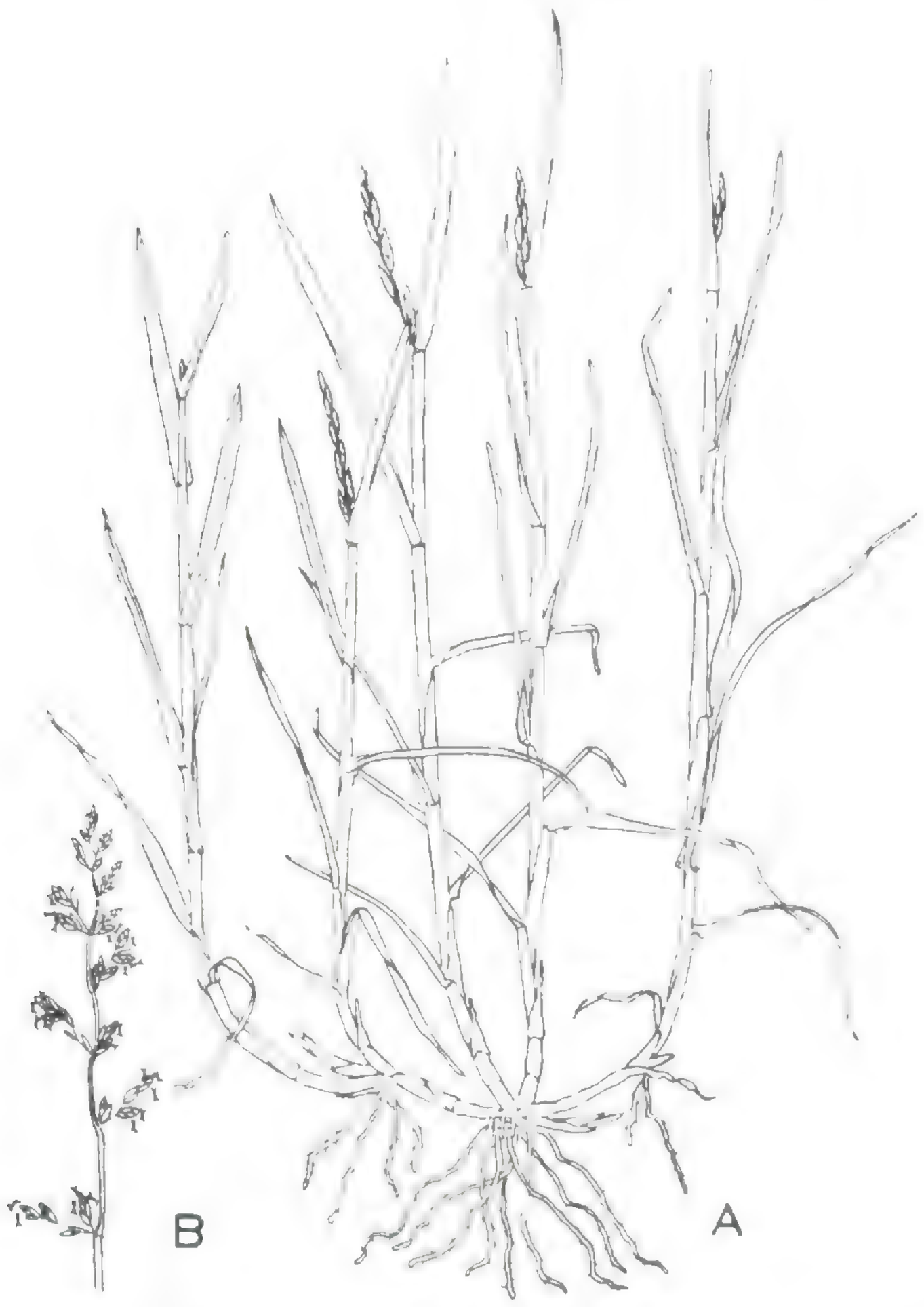


Fig. 3. Canadian blue grass, *Poa compressa*. A, habit when just coming into flower (× ½); B, inflorescence much later (× 1).

During the summer Canada blue grass makes a sparse ragged gray-blue-green turf, usually on poor dry soil in places where Kentucky blue grass will not succeed.

CRAB GRASS OR WATER GRASS (*Digitaria* spp.).—There are really two species of crab grass in St. Louis, *Digitaria sanguinalis* and

D. Ischaemum, but since the differences between them are slight and highly technical they may be considered under a single heading. Crab grass is a summer annual, germinating late in the spring, growing rapidly during the hot weather, and dying with the first heavy frost. It first begins to show just before blue grass comes into flower, about the second week in May in the average

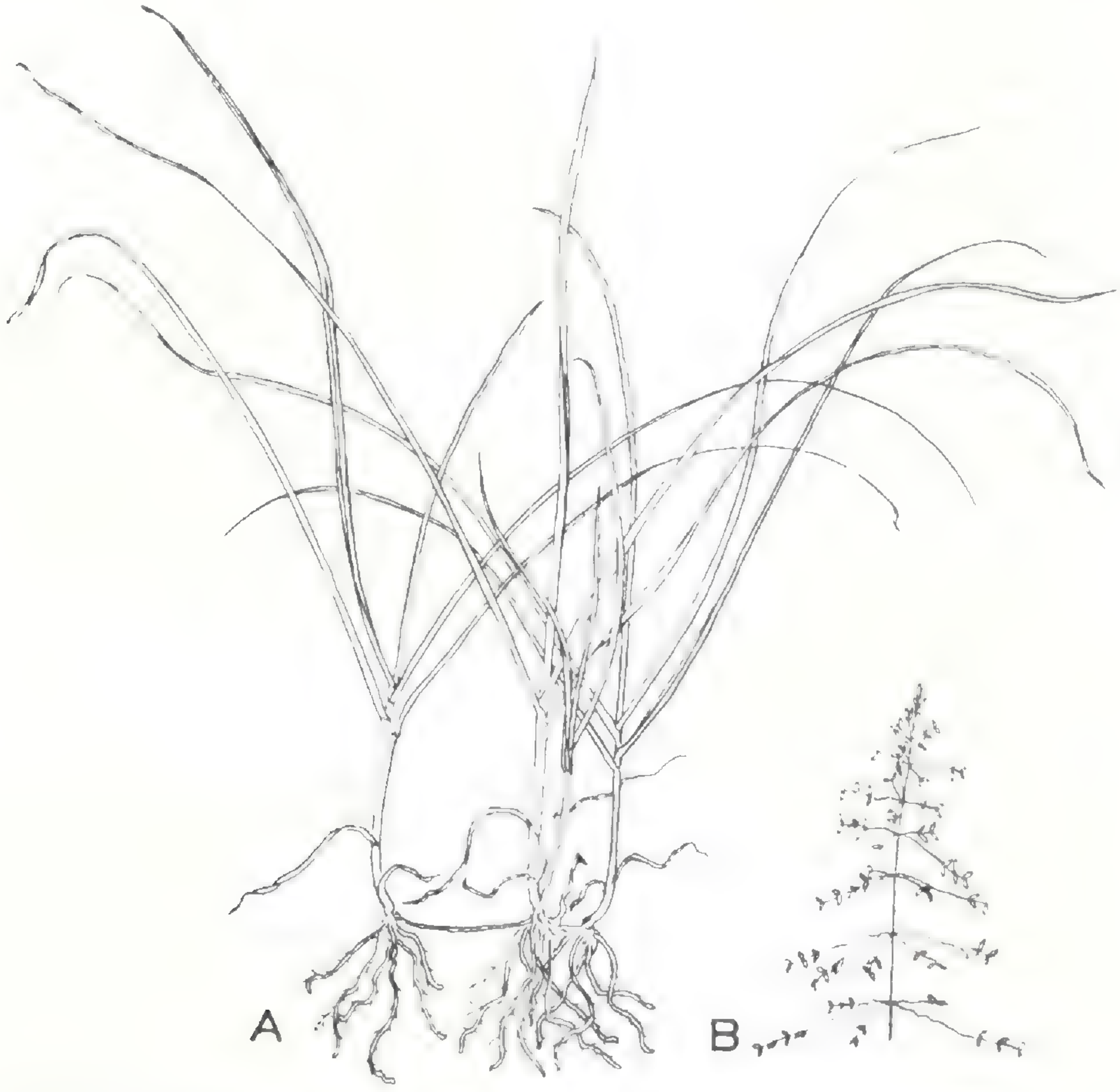


Fig. 4. Woods grass, *Poa sylvestris.* A, habit (× ½); B, inflorescence (× ¼). A native species that shows promise as a ground cover in dense shade.

spring. At this time it has only one or two leaves and the lawn must be examined carefully to find it, but it is easily recognized even at this early stage. The leaves are broad for their length and are a much yellower green than those of blue grass or even redtop. With the beginning of hot weather it grows rapidly, branching at nearly every joint, as shown in figure 5. It does not, however, rise up straight but makes a mat-like growth, all the

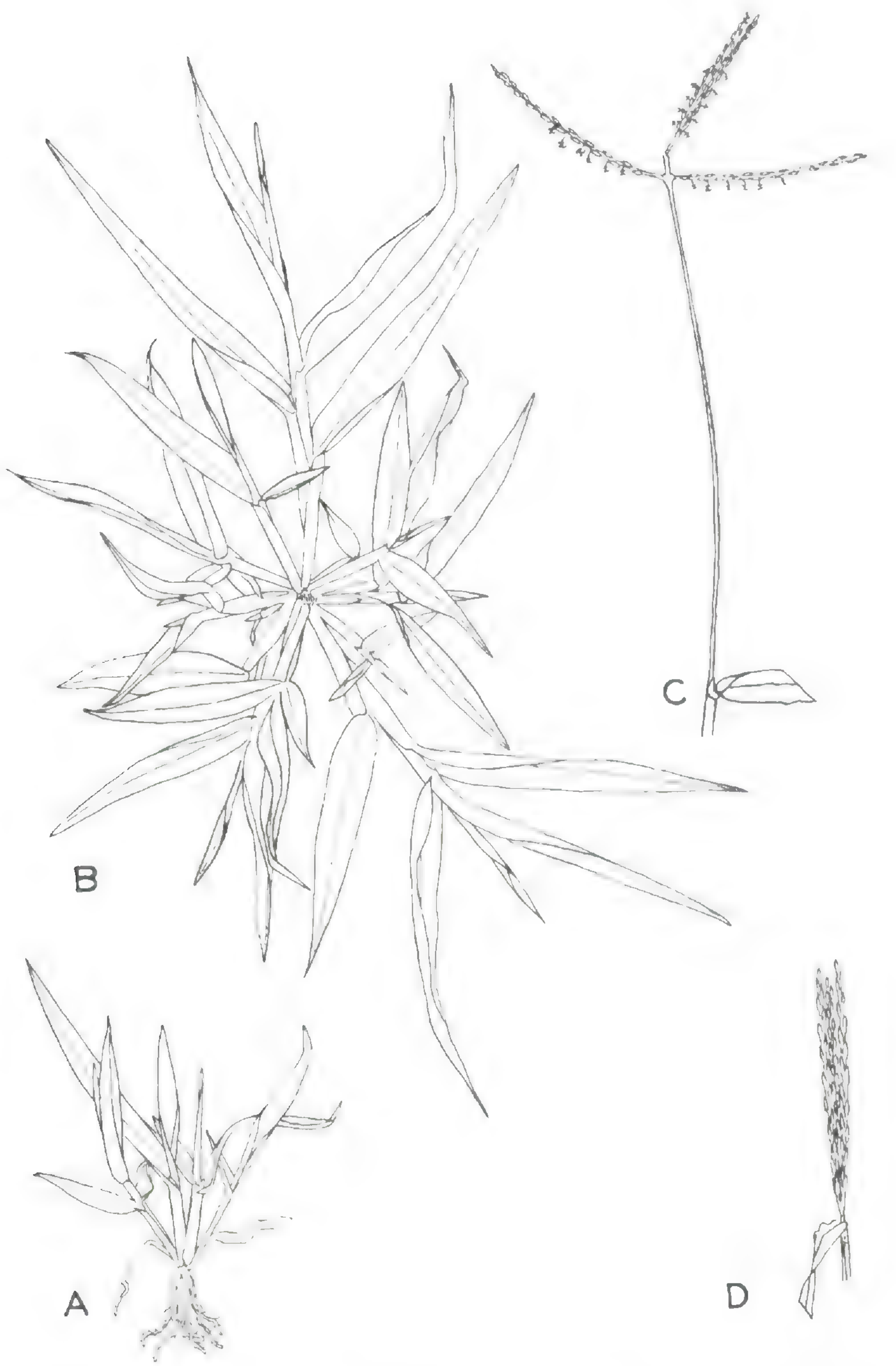


Fig. 5. Crab grass, *Digitaria sanguinalis* (× ½). A, young plant; B, older plant; C, mature inflorescence; D, young inflorescence.

stems going back to one central root system. In midsummer it begins to flower and looks more unsightly. The flowering tassels stay down within the turf, if the lawn is mowed, and appear as darker bundles of wiry stems covered with tiny seeds. The tassel is branched, often in three parts, in a characteristic "crow-foot" pattern (fig. 5). In the late summer crab grass reddens slightly and with the first heavy frost most of it dies, showing up immediately in a mixed turf as patches of dirty brown. The lawn remains dead and withered-looking throughout the winter until it is covered with new grass the following spring. In the middle of a

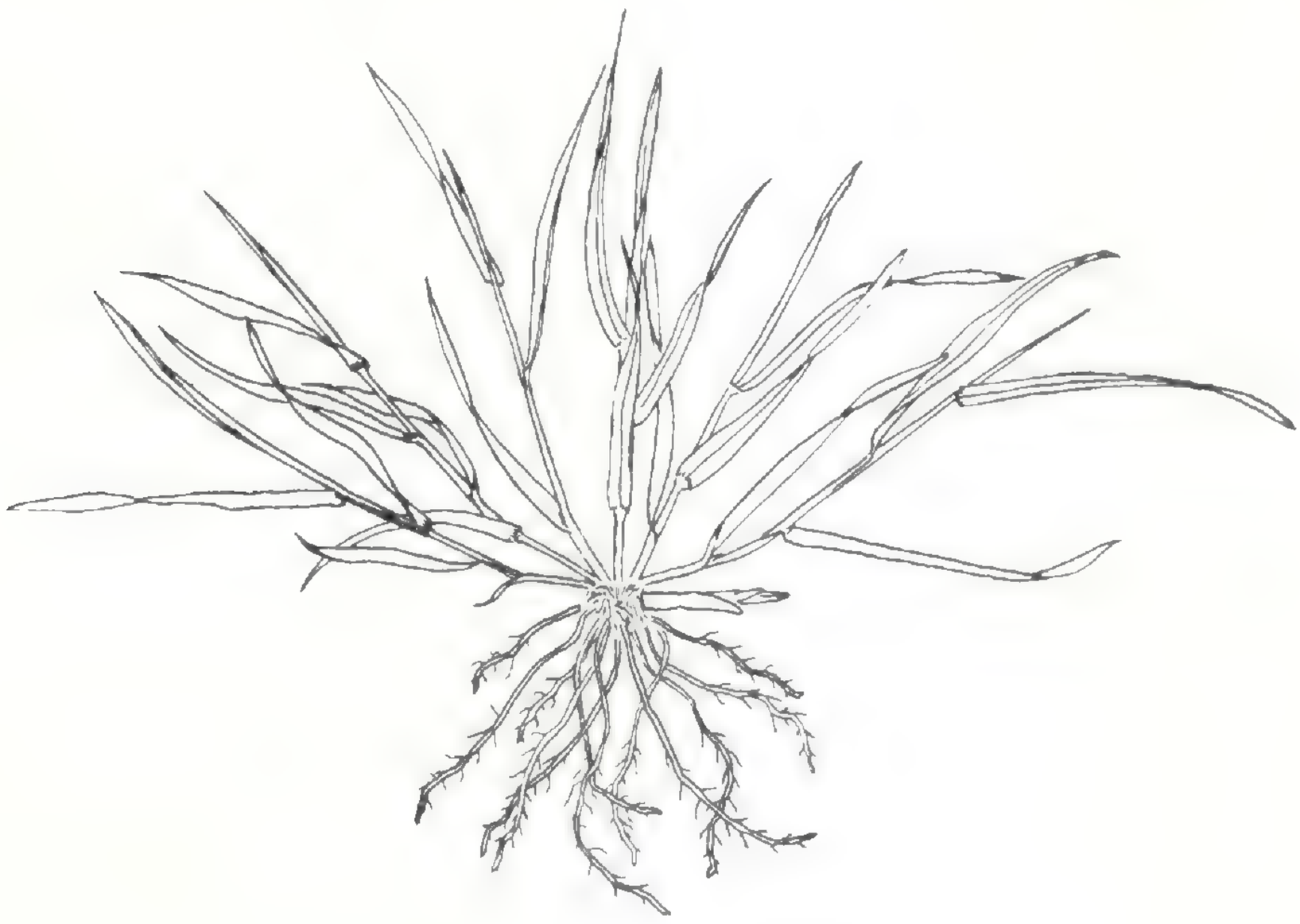


Fig. 6. Redtop, *Agrostis alba* (× ½).

hot summer, when other grasses are not doing well, crab grass with its lush growth and pleasant yellow-green color is a fairly attractive lawn, though rather coarse. However, from the time of the first cold weather until late the following spring it is very unsightly and for this reason is not to be recommended. It is, in fact, the worst weed in St. Louis lawns, and the chief aim in managing a good lawn should be to encourage the desirable grasses without encouraging crab grass.

REDTOP *(Agrostis alba)*.—A well-developed plant of redtop would never be confused with any of the other lawn grasses in

St. Louis but recognizing it with certainty in the turf at all times of year is somewhat more difficult. Its outstanding characteristics are its wide leaf, with a spear-shaped tip, its yellow-green color, and its sprawly growth habit. It begins growth much later in the spring than blue grass and grows even more rapidly, soon making large spreading rosettes of lighter green in the blue-grass turf. The leaves do not rise up straight, like those of blue grass, but reach out at an angle, displaying their broad yellow-green blades conspicuously (fig. 6). Redtop grows quickly from seed and it is often used in St. Louis to give a "quick" effect, but if the grass succeeds it is a perennial and will be much coarser the second year. While it has its use in shady areas and on sourer soils it is too coarse and bunchy for the best turf.

In grasses there is a sort of miniature circular gutter at the point where the leaf is wrapped around the stem, known technically as the ligule. Redtop has a distinctively long ligule as compared with blue grass, a fact which is often helpful in identifying small or closely clipped plants. It is closely related to the creeping bents, as can be seen when an entire plant is pulled up out of the turf. Like them, it has the ability to creep along the surface of the ground, occasionally rooting at the joints, though this habit is nowhere nearly so well developed as in the creeping bent grasses.

Sporobolus vaginiflorus.—Within the first month of our study of the lawn problem in St. Louis we found a small, fine-textured grass on dry sunny banks which we had great difficulty in identifying. Even the experts could not recognize it until it flowered. Although it is one of the commonest grasses in St. Louis it is not mentioned in any book on lawn grasses. Because of its delicate leaves and small wiry stems it is often mistaken for a fescue or even a bent grass. It is distinguished from both of these, however, by its upright growth, by being an annual, and by the tiny "whiskers" at the point where the leaf joins the stem (fig. 7).

Though it should be listed with the weed grasses, Sporobolus is not unattractive. It makes a fine though wiry turf and is not aggressive, mainly limiting itself to those spots which are too hot, or too dry, or too sunny for other grasses to do well. As a matter of fact, if it would only begin growth in March instead of May it

might be recommended and deliberately planted in many such situations in the St. Louis area.

RYE GRASS (*Lolium* spp.).—Two species of rye grass are found in St. Louis lawns, *Lolium perenne* and *L. multiflorum*. *Lolium perenne* is perennial and *L. multiflorum* annual, but other differences between the two are technical and for our purposes the following description will apply equally well to either. The rye grasses resemble Kentucky blue grass in that they occur in the

Fig. 7. *Sporobolus vaginiflorus* (× ½).

lawn in small bunches, but in other respects the two grasses are very different. By the following two characters they may be classified in the turf even when their flowers are absent. Their leaves are strikingly *glossy* when seen in the sunlight and the nodes (joints) of the stem are swollen so that they are almost one-third larger than the portions of the stem between the nodes (fig. 8). The plants do not have underground runners; the leaves are spear-shaped at the tip (not boat-shaped); and the tassel is very narrow and spike-like, with the individual spikelets pressed

Fig. 8. Perennial rye grass, *Lolium perenne*.
A, habit (× 2/5); B, joint (× 4/5).

closely against two sides of the stem. The leaves contain large amounts of silica which makes cutting them with a lawn-mower difficult. Rye grass begins growth in the spring about the same time as redtop. When the weather becomes hot the leaves tend to curl up and turn somewhat brown. With cool weather the plants resume growth and by the latter part of September they again form a glossy, dark green turf.

BERMUDA GRASS *(Cynodon Dactylon)*.—Bermuda grass is so very different from all other grasses found in St. Louis lawns that it should never be mistaken for anything else. The stems, instead

Fig. 9. Shepherd's purse, *Capsella Bursa pastoris* (× ½).

of growing up into the air, creep along the surface of the ground. If one of them is removed from the turf it is found to possess a joint at about every 1½ inches along its length, with smaller leafy stems sticking up at each joint. The leaves are dark green, narrow, and usually not more than one inch in length. The stem arches between each joint, giving a definite scalloped effect when viewed as a whole. Roots are often found on the under-side of the joints. When in flower the tassel of Bermuda grass resembles that of a miniature crab grass. The plant is a perennial but it is of southern origin and sometimes freezes out in St. Louis during the winter. In summer months it forms a dark green turf, but with the first frost its leaves turn brown and remain so until late the fol-

lowing spring, when it begins to green up just before the appearance of crab grass, about the latter part of May.

LAWN WEEDS.—Many kinds of plants other than grasses may be found in St. Louis lawns but only three, knotweed, chickweed, and shepherd's purse, are small enough and occur with such frequency as to be considered a regular feature of the lawn. Since they are not grasses, they are easy to tell apart and their distinguishing characteristics are well shown in figs. 9, 10 and 11. Chickweed and shepherd's purse are more apt to be met with in the spring, particularly the early spring, while knotweed reaches a maximum in late summer. Knotweed flowers are inconspicuous but the weed can be recognized by the curious tissue-paper sheaths which occur at the joints of the stem.

Fig. 10. Knotweed, *Polygonum aviculare* (× ½).

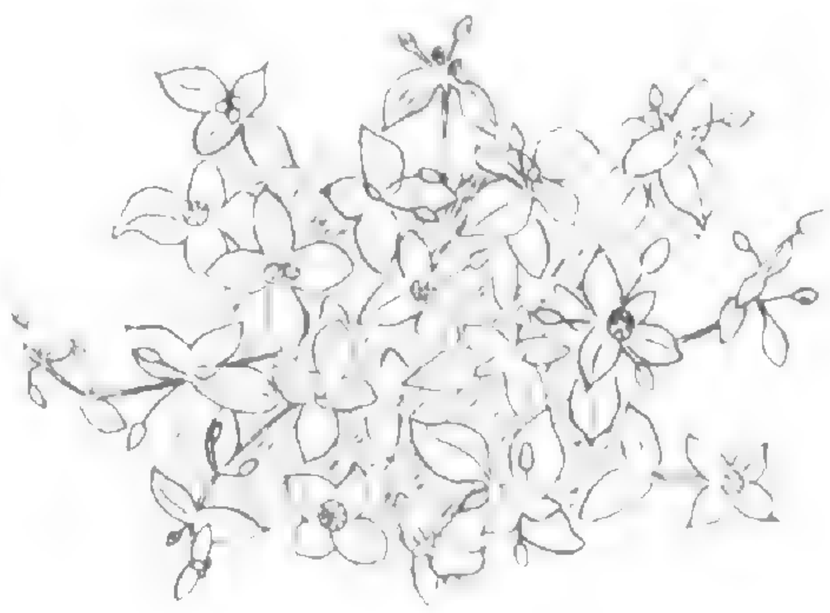


Fig. 11. Chickweed, *Stellaria media* (× ½).

LAWN BEHAVIOR

After one is able to distinguish the various grasses and weeds found in the average lawn the next most important step in successful turf management is a knowledge of the periodic behavior of the individual plants composing the sward. It is obvious that if we are to aid plants in their growth and development we must first familiarize ourselves with their natural inclinations.

Grasses, like all groups of plants, follow very definite and precise growth patterns and rhythms. These do not change within species but for two different kinds of grass they are always decidedly different. As an illustration let us take the common Kentucky blue grass, *Poa pratensis*, and consider it as being made up

of culms (stems), leaves, rhizomes, roots, and inflorescences (see frontispiece). If such a plant is removed from the soil in early March and carefully examined it is found that the roots and rhizomes are developing very rapidly while the leaves are showing only slight growth and the flowering culms have not yet appeared. If the same plant is examined the latter part of April one finds leaf growth to be very rapid. The rhizomes will be develop

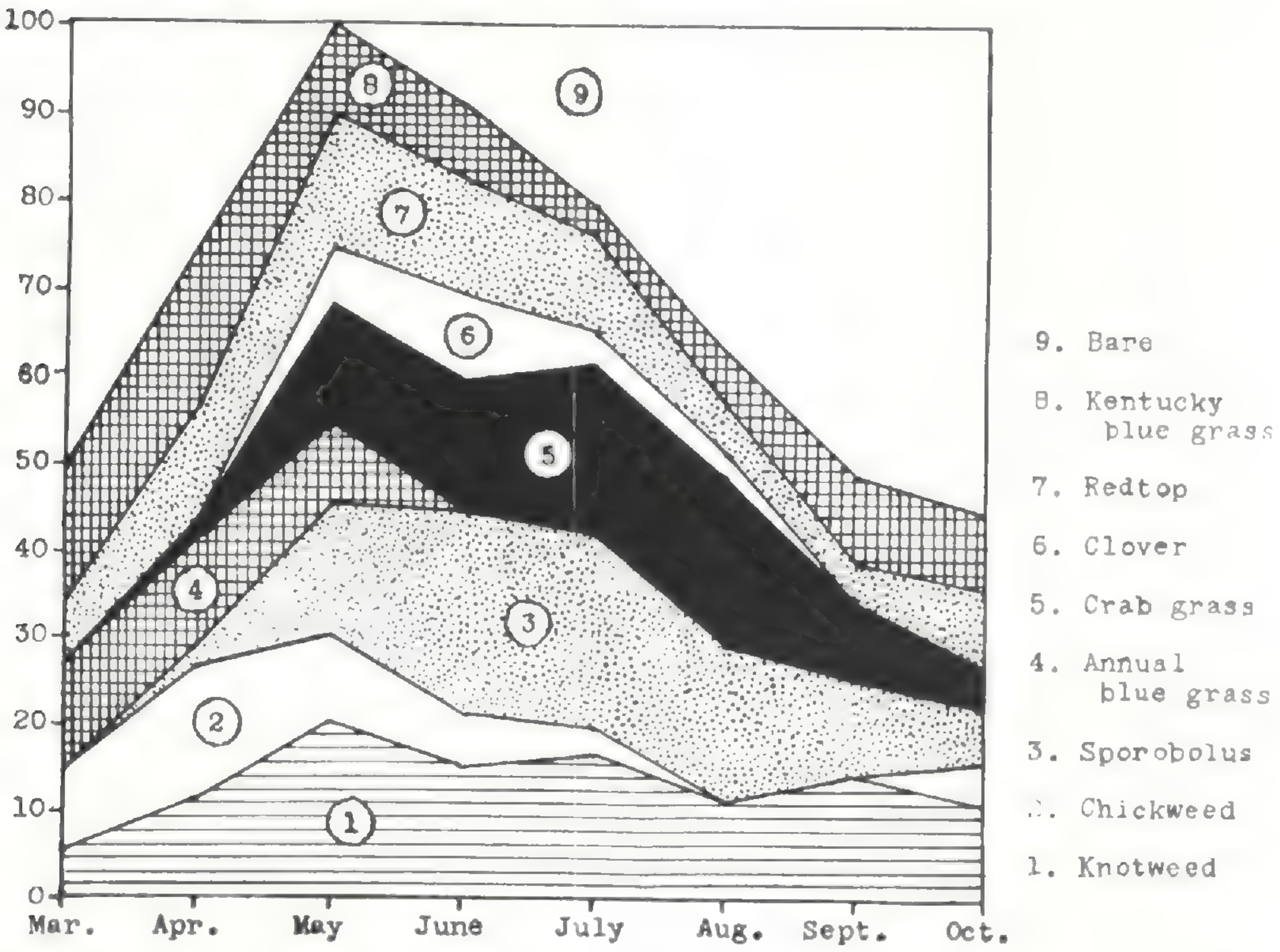


Fig. 12. Showing seasonal changes among grasses of an average St. Louis lawn. Note percentage differences of the same grasses at different months during growing season.

ing but their growth is not as vigorous as it was in early March. When the plant is studied in July or August most of its organs are found in a state of semi-dormancy. In September or October the plant revives and growth at this time simulates that which occurred in early spring.

For a thorough understanding of lawn behavior and as a basis for lawn improvement it is necessary that we have this type of information on all the more important turf grasses and weeds. An attempt to obtain such at the Missouri Botanical Garden was first

made in 1938. At that time a series of nine quadrats, each one yard square, was laid out in nine very different situations in the Garden. Beginning the first week in March these were mapped at weekly intervals until fall. At the end of the season the maps gave us a fairly good idea of what plants were in the quadrats (fig. 12) but the information most needed—what the various species were doing week by week throughout the season—was not available. Beginning in March, 1939, the growth of the various organs composing the more important turf plants was recorded week by week. For example, the rhizomes of blue grass were given a score of 0, 1, 2 or 3, according to their rapidity of development. The same was done for roots, leaves, stems, and inflorescences, not only of blue grass but also of redtop, crab grass, Sporobolus, white clover, chickweed and knotweed. At the end of the growing season the data presented a rather definite and precise picture (fig. 13) of the behavior of the grasses and weeds. It should be remembered that this data can be applied only to 1939. Grasses do not always behave in the same way, year after year, and if the plants were scored another year the picture would undoubtedly vary somewhat from that which we have presented.

The 1939 data on grass development have been summarized pictorially in figure 13. The horizontal lines represent stolon or rhizome growth, the rate of growth being indicated by the width of the line (a broken line indicates that growth was at a standstill). The leaves of the plants are represented in the diagram as V's. The absence of a V means that there was no noticeable leaf development during that particular week. The vertical lines represent stems, and the height of the lines show the relative rate of development. Flowering is represented by circles.

As shown in figure 13, in March, 1939, Kentucky blue grass, annual blue grass, and chickweed are already showing rapid growth while redtop has just started to develop. Annual blue grass has begun to flower; neither crab grass nor Sporobolus has yet appeared; and white clover is still dormant except for some stolon activity. During the month of April leaves and rhizomes of blue grass continue to develop very rapidly. Chickweed is nearing the height of its vegetative development and has already started to flower. Redtop also shows a marked vegetative increase while crab grass and Sporobolus are still not noticeable.

May finds the blue grasses flowering, and this is accompanied by a decrease in vegetative activity. At this time redtop is very conspicuous since its leaf growth rate is now at a maximum. Chickweed is still going strong and small crab grass seedlings are beginning to appear for the first time. In June the appearance of an average lawn changes very rapidly. One of the most conspicuous features is the flowering stems of redtop, some of which always escape the mower. Light yellow patches begin to show up in the turf, a result of the dying annual blue grass. At this time crab grass springs forth with a sudden burst of activity and practically dominates the lawn within the period of one month. If clover is present it will also show up since it is at the height of its flowering period. Sporobolus also makes its appearance during June but remains more or less inconspicuous during its first month of growth. With the approach of hot weather in July there are decided changes in the behavior of the turf. Blue grass now enters a period of semi-dormancy which is compensated by increased activity on the part of crab grass. The growth of redtop is also retarded but not to the same extent as that of blue grass. Sporobolus is at about the height of its development, and chickweed has practically disappeared. If moisure is present, clover will still show considerable activity; otherwise it becomes an inconspicuous feature of the lawn. From now until the middle of September only minor changes take place among the lawn constituents, but at the beginning of fall there is again a decided change in their behavior. As cool weather approaches the activity of crab grass and Sporobolus increases and with the first heavy frost they are killed, leaving large brown patches. However, surrounding the brown patches and springing up among the dead leaves will be noticed the new shoots of blue grass. These become very active as the weather becomes cooler and if present in considerable amounts they will produce a dark green turf well into the winter. Redtop also starts new growth in the fall but it is not so pronounced as is that of blue grass. Thus we see that the lawn as a whole undergoes a series of complicated changes in the course of one growing season, and whether or not we want to eliminate some elements, encourage others, or merely assist the lawn in its struggle, our success is dependent upon a knowledge of what is taking place throughout the season.

Figure 13 is an attempt to summarize in a single diagram what eight of our most important lawn grasses and lawn weeds are doing throughout the growing season.

The facts on which the diagram is based were gathered during 1939; every week of that year a record was made of the activity of rhizome, leaf, stem and flower for these species. They have been combined into a kind of picture of the development of each plant. In the case of white clover, redtop, and Kentucky blue grass, the lines across the page represent rhizome growth (the thicker the line the more active were the rhizomes, while a dotted line means little or no rhizome growth). The upright V's represent the leaves (the higher the V, the more vigorous were the leaves). In the same way the upright lines show what the stems were doing, and the black circles the flowers. Small circles, of course, mean that the plants were flowering a little and the bigger circles mean more active flowering.

The months are listed at the bottom of the figure, and all of the plants are diagrammed to the same scale of weeks. It is interesting to see how some of our common grasses and lawn weeds fit together into a lawn. Chickweed dies down just as crab grass is coming on; the summer pest taking the place of the spring pest, so to speak. Kentucky blue grass is seen to have its period of greatest activity just prior to the appearance of the crab grasses. To those who are interested in why St. Louis lawns act the way they do, this figure is worthy of a good deal of study. From it one may learn the way in which the grasses and weeds of a lawn fit their activities together, like a jig-saw puzzle, the pieces of which are changing their shapes and sizes from day to day and week to week.

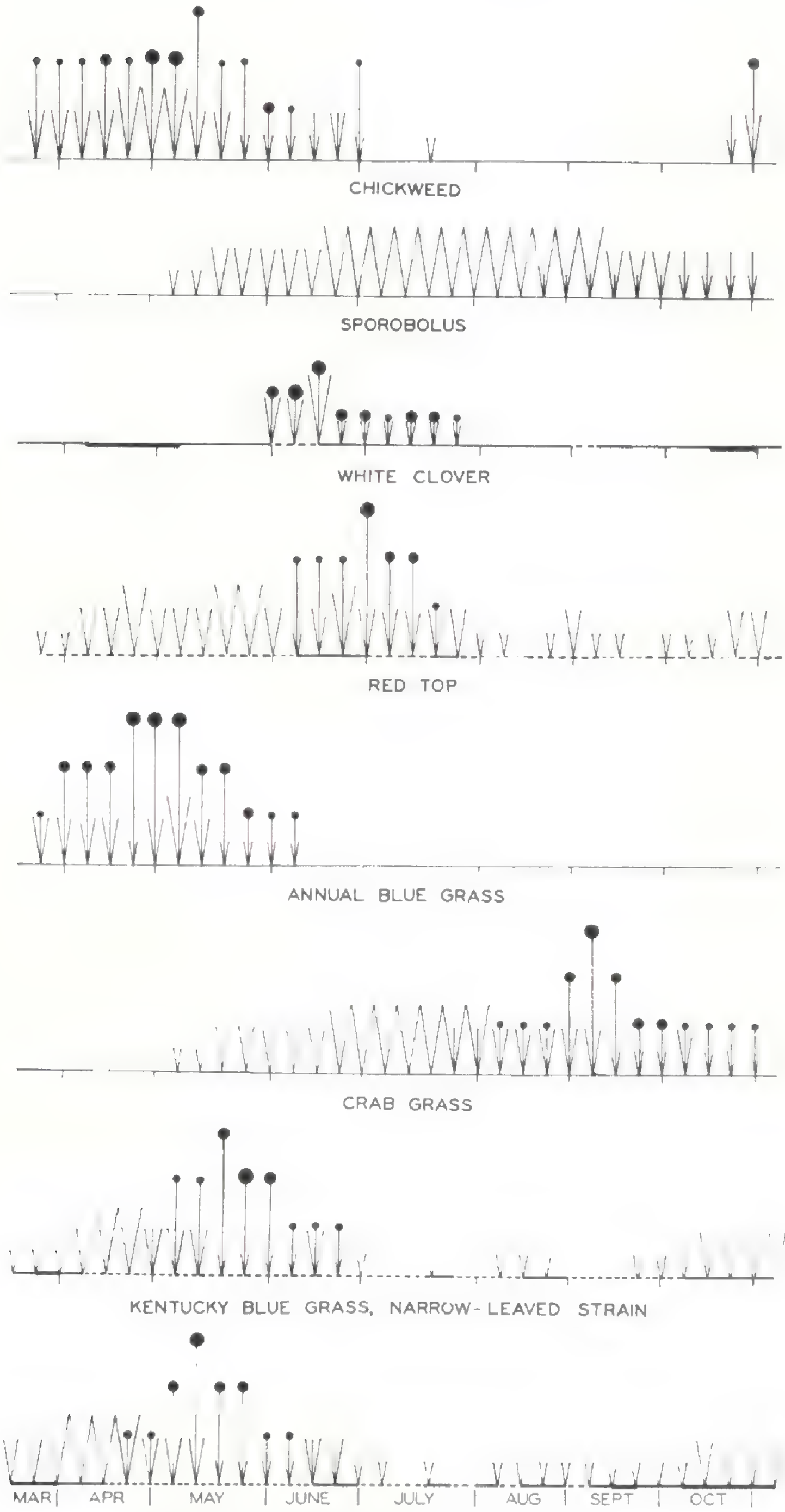


Fig. 13. See explanation on opposite page.

PRELIMINARY RESULTS OF EXPERIMENTAL WORK

Fertilizers.—The types and amounts of fertilizers best suited for lawns in St. Louis will be discussed later on in the paper. However, at this point some mention should be made of the preliminary results of the few fertilizer experiments now in progress at the Garden. The first of these concern ammonium sulphate. This fertilizer is extensively used and highly recommended as a source of nitrogen. It does contain approximately 20 per cent nitrogen and brings about very rapid results if applied to grasses in either spring or fall. New vigorous green growth can often be observed in a lawn ten days after it has received an application of ammonium sulphate. Obvious stimulation of growth continues for a month or six weeks, after which the fertilizer seems to become exhausted just as rapidly as it became available. It is known that continued use of ammonium sulphate may bring about an acid condition in the soil, but with this exception little information is available on the effect in succeeding years.

In order to gain some information on ammonium sulphate a fertilizing experiment was started at the Garden three years ago. A plot of turf consisting of blue grass, redtop, crab grass, and some white clover was selected and divided in halves. To one half of the plot ammonium sulphate was applied each spring (the first week in April) at the rate of 2 pounds of nitrogen per 1000 square feet. The other half received, each spring, a light top dressing of peat moss. Three weeks after the first treatment the plot receiving the ammonium sulphate exhibited a lush green growth of grass which appeared much more vigorous than that receiving only peat. After two months, however, the differences in growth became very slight and throughout the remainder of the season the two plots behaved in an almost identical manner. The early results, following the second treatment, simulated very closely those of the first year. Vigorous growth followed the application of ammonium sulphate for about two months, after which differences began to be manifest in the turf. The blue grass in the plot receiving only peat moss maintained active growth for a longer period during the summer than did that which had been treated with ammonium sulphate. Also more crab grass appeared in the plot treated with ammonium sulphate than in the one receiving

only peat. These effects were still more pronounced following the third treatment until at the present time the ammonium-sulphate plot contains about 75 per cent crab grass while blue grass has increased considerably in the plot receiving no treatment other than a light annual top dressing of peat moss. On the basis of these results it would seem that ammonium sulphate, when used alone, has a somewhat harmful after-effect on blue grass turf. What the effect would be if it were used in combination with lime or with other fertilizers is not known. The experiment is still in progress and will be much more conclusive after several more years.

Further experiments, designed primarily to determine the practicability of using sewage sludge as a source of nitrogen for lawns, have been running for two years. Sewage sludge is available at small costs and in relatively large amounts in the vicinity of St. Louis. It has been used considerably in growing greenhouse plants but its effect on lawn grasses is not yet known. Two years ago an experiment, designed to show the comparative effects of sewage sludge, complete fertilizer, and lime, was started at the Garden. The complete fertilizer (analysis 10-5-3) and sludge were applied in September at the rate of 2 pounds of nitrogen per 1000 square feet. Lime was added at the rate of 20 pounds per 1000 square feet. After the first treatment the following effects were observed: Differences in the behavior of the turf receiving the two fertilizer treatments were slight, but the time at which these differences occurred was marked. The plots receiving sludge showed a decided increase in growth three weeks after treatment. This difference was noticeable for about one month, after which it disappeared entirely. The plots receiving complete fertilizer responded more slowly, and growth increases were not evident until about five weeks after treatment. However, the stimulating effects of the fertilizer were noticeable throughout the fall growing season and also showed up in the early growth the following spring. During the first year no differences were observed in the grasses of those plots receiving lime and those receiving no treatment at all.

Results of a second treatment were somewhat different from those of the first. Again the grass responded very quickly to the

sludge, but this time the response continued to be apparent over a much longer period than that following the first application. In fact, the greatest growth increases were observed in the spring following treatment the previous fall, and these effects continued to be noticeable throughout most of the summer. Grasses in those plots receiving complete fertilizer behaved in the same manner as they did following the first application. An increase in the number of weeds in those plots treated with lime two years in succession was significant, but no marked differences were observed in the behavior of the grass in these plots and those untreated.

Although these experiments will have to be continued over a number of years before any definite conclusions can be drawn, our preliminary conclusions are that sewage sludge may have a place in St. Louis as a lawn fertilizer. The primary objection to it at present is the mechanical difficulty involved in handling. If used in the liquid state it is necessary to have a tank equipped with a centrifugal pump for transporting and distributing it. However, if it does prove to be superior to commercial fertilizer (or even a good substitute), the differences in cost between it and commercial fertilizers would perhaps justify the expense of a tank. If a number of gardeners cooperated in such a project the individual cost would be slight. Another objection to its use is that the lawn is unsightly immediately following its application. If applied in the late fall, however, the sludge is conspicuous for only three weeks following its application, and by the following spring it has disappeared from the surface entirely.

Raking.—In our opinion raking is one of the more important and perhaps the most abused cultural practice applied to St. Louis lawns.

If the above statement were based on mere opinion it would have little if any significance, but experiments in progress at the Garden during the past three years indicate that *spring* raking is not beneficial and in some cases at least it actually harms the turf. In the spring of 1938 a plot of turf containing a mixture of blue grass and redtop, along with some crab grass, was chosen for a raking experiment. So far as one could judge from observation the turf was homogeneous throughout the plot. The plot was divided in half and each April one half was raked and the other left unraked.

At the end of the first year the unraked half appeared to be slightly better than the raked one in that it contained less crab grass and more of the desirable grass species. The differences between the two were not great but they were detectable. At the end of the second year they were more pronounced, and after a third treatment the unraked half of the plot appears to be decidedly superior to the raked half in that it contains less crab grass and more blue grass and redtop.

The fact that many lawns contain a large amount of crab grass is perhaps the reason that spring raking is so common. After the crab grass turns brown gardeners generally lose little time in getting rid of it by vigorous raking. Perhaps some believe that by removing the dead grass the crab grass will be checked or eliminated. Others rake it with the hope that its removal will help the appearances of the lawn. If it were possible to remove all the ripened seed along with the dead leaves and stems, no doubt raking would be justified since crab grass is an annual and returns each year from seed and not from the previous year's plant. This, however, is not possible. Very few crab grass seeds are removed by raking—they are merely threshed and a good number are undoubtedly well planted by the raking process.

Let us consider our turf as it would be if it were not raked. Assuming that some crab grass were present, after it has died in the fall a number of more or less unsightly brown patches result. However, it is not likely that these will be more unsightly than equally large patches of bare ground, and the presence of dead material on such spots can be taken advantage of in reseeding. If, in September or October, seed is sown among the patches of dead grass and then worked down onto the surface of the ground with the back of a rake it has the advantage of having over it a moisture-conserving mulch which will aid in germination and protection during the coming winter. By the time rapid growth starts the following spring the dead crab grass plants will have almost disintegrated and the soil will undoubtedly profit from the addition of the resulting organic matter even though it be in small amounts. It is our conclusion, therefore, that unless a lawn is to be rebuilt from scratch the annual removal of dead crab grass by raking has no beneficial effect and is perhaps even harmful.

Blue Grass Improvement.—In our opinion Kentucky blue grass is still the most important lawn grass in St. Louis. Though a European grass which has been in America only a few hundred years, it is nevertheless peculiarly adapted to our soils and climates and the better pastures in the countryside near St. Louis will be found to have fine natural stands of it. A census of grasses in St. Louis lawns showed us that it was the most important non-weed grass in the city, even in areas where other grasses have been planted. A series of experiments has been undertaken to learn what fertilizers offer the most encouragement to Kentucky blue grass under city conditions and in what ways blue grass might be improved.

The corn, tobacco, and various other crops grown by the early settlers in this country would hardly be recognized as such by present-day farmers. Blue grass, on the other hand, looks to-day just as it did hundreds of years ago. The reason for this is of course apparent. Most crop plants have been greatly improved while the lawn grasses, with few exceptions, have received no attention from the plant breeder. This does not mean that lawn grasses cannot be improved; it merely means that up until the present they have been neglected.

When a careful study of blue grass was begun at the Missouri Botanical Garden it was almost immediately apparent that, as a whole, it is an amazingly variable species. It includes wide-leaved races and narrow-leaved ones, tall "hay" types, and spready "pasture" types. Any old pasture where blue grass has been growing for a number of years is a collection from which one can gather many different sorts of grass, but all of them blue grass. When one buys blue grass seed for his lawn, however, he does not obtain any such collection. The reason for this is obvious. The seed is raised on large farms, just as any other crop, and is stripped, then threshed, like wheat or oats. Ever since this has been going on there has been an unconscious selection of "hay" types, and the low-growing spready sorts have been eliminated. Yet the latter are the types of blue grass which would do the best as a lawn grass. We have, in other words, been selecting *seed for sod* where we should have been selecting *sod for seed*.

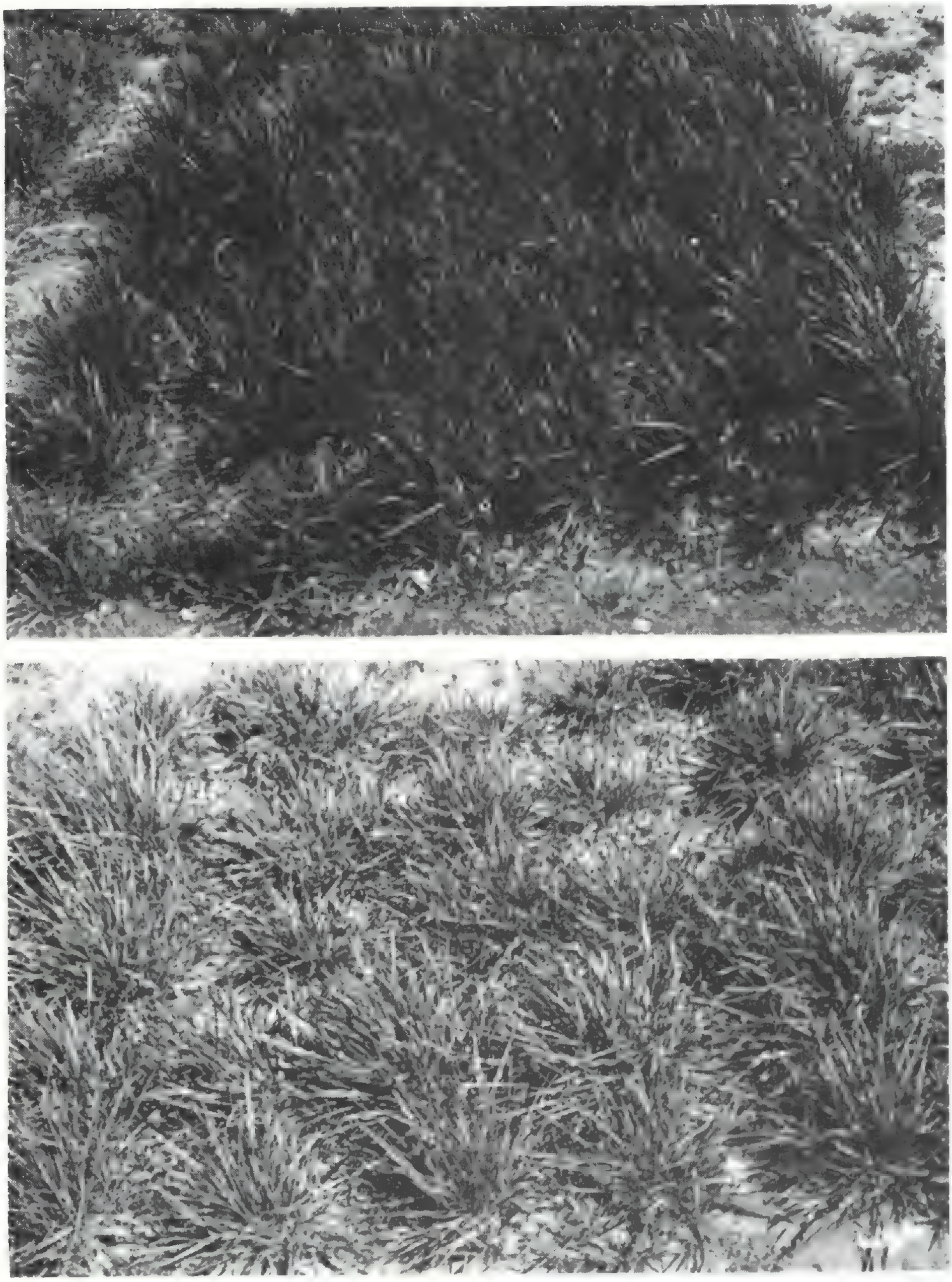


Fig. 14. Two promising selected strains of Kentucky blue grass: above, upright narrow-leaved strain; below, low-spreading wide-leaved strain.

During the past three years a collection of blue grass plants has been made at the Garden from the old pastures and lawns in Missouri and neighboring states. These represent different strains, many of which have the advantage of having undergone long periods of natural selection under climatic conditions very similar to those under which we are attempting to grow lawns. Plants which showed promise as lawn grasses were selected from the collection, planted in turf plots, and treated in the same manner as lawns in general. Throughout the year they were frequently checked to determine their resistance or susceptibility to disease, heat, drought, and cold. Emphasis was also placed on their ability to propagate vegetatively, this being an important factor in the maintenance of a dense weed-free turf.

At present two selected strains (fig. 14), both of which differ decidedly from ordinary "market" blue grass, show considerable promise. However, as they have been tested in the lawn for only one year few definite statements can be made concerning them. Nevertheless, they do seem superior to ordinary Kentucky blue grass in the following ways: (1) Increased vigor. (2) More rapid vegetative propagation through rhizome development. (3) Growth starts earlier in the spring. (4) Greater resistance to high temperatures. (5) One of the two strains seems to maintain growth throughout the summer instead of assuming a semi-dormant state during July and August. The leaves of these new plants are considerably wider than those of ordinary blue grass. This may be considered as objectionable by some persons, but for lawns in general it would probably be expedient to sacrifice narrow leaves for increased vigor.

The propagation of desirable local strains of blue grass has also been in progress for three years. Seed of promising strains are selected each summer and harvested at the Garden Arboretum at Gray Summit. In the fall these are sown in plots along side commercial seed and the resulting crops compared. At present these plantings total approximately twenty acres and with few exceptions the native strain has proved superior to that produced from commercial seed.

The above discussion is intended to give the gardener some

idea as to what is being done in the way of developing superior strains of lawn grass. It should be emphasized that before selected seed is available to the public, extensive tests and certification are necessary, all of which require considerable time. We feel, however, that before many years the St. Louis gardener will be able to purchase lawn-grass seed that has been selected and developed for his particular needs, just as the farmer has now available corn varieties whose yields have been doubled during the past twenty-five years.

Chemical weed control.—In 1939 two experiments were started at the Garden. The first of these was designed to test the effectiveness of sodium chlorate and ammonium sulphate in controlling chickweed. Test plots were laid out in a blue grass-redtop lawn which at that time was heavily infested with chickweed. Both chemicals were applied in solution the second week in March, the following concentrations being used: sodium chlorate—1½, 2, and 3 oz. per gallon of water; ammonium sulphate —½, 1, and 2 lbs. per gallon of water. Ten days following the first treatment a second application was given the same plots, this time the concentrations being reduced to half the original amounts. Chickweed was killed 100 per cent in those plots treated with sodium chlorate in concentrations of 3 oz. per gallon. At the same time, however, 50 per cent of the grasses were killed and those remaining were seriously damaged. The 2-ounce treatment killed approximately 70 per cent of the chickweed. Only a small per cent of the grasses were killed but their growth was seriously retarded for a period of six weeks. Concentration of 1½ oz. eliminated 35 to 50 per cent of the chickweed and the grasses became slightly brown for about ten days, after which they resumed normal growth. The results with ammonium sulphate were negative. Concentrations of one pound per gallon merely stimulated the growth of all vegetation in the plots. One and one-half pounds caused slight burning but none of the plants were killed. Two pounds killed a small percentage of the chickweed, but that which remained developed more rapidly after it had recovered from the first shock. The plan of another experiment started at the same time as this one is shown on the opposite page.

10	9	8	7	6	5	4	3	2	1	0
2	1	0	10	9	8	7	6	5	4	3
5	4	3	2	1	0	10	9	8	7	6
8	7	6	5	4	3	2	1	0	10	9
0	10	9	8	7	6	5	4	3	2	1

Chart showing layout of plots for chemical weed control.

0—Sodium chlorate, 1½ oz. per gallon.

1—Ammonium sulphate, 1 lb. per gallon.

2— Ammonium sulphate, 3 parts.
Iron sulphate, 1 part.
Sand, 20 parts.

3—Iron sulphate, 4 oz. per gallon.

4—Arsenate of lead, 1¼ lbs. per gallon.

5—Sodium arsenate, 3 oz. per gallon.

6— Iron sulphate, 3 parts.
Ammonium sulphate, 1 part.
Sand, 20 parts.

7—Sulphur, ¼ lb. per 100 sq. ft.

8—Complete fertilizer (12-6-4), 10 lbs. per 100 sq. ft.

9—Aluminum sulphate, 2 oz. per gallon.

10—Control.

In this layout ten chemicals were used, each being replicated five times. Unfortunately the experiment had to be discontinued at the end of one year, and as a result no definite conclusions can be drawn regarding the effectiveness of any of the materials used. However, some differences were observed between treatments. The application of complete fertilizer, ammonium sulphate, and ammonium sulphate and iron sulphate in combination resulted in

an increased vigor in the turf grasses which tended to crowd out such weeds as knotweed and shepherd's purse. Plantain and dandelions, however, profited from the fertilizer in the same manner as did the grasses. Some chickweed and shepherd's purse were eliminated by the sodium chlorate and sodium arsenate treatments while plantain and dandelions were not affected except for slight retardation in growth. Both these treatments caused the grasses to brown slightly for a period of ten days, but they soon revived and resumed growth.

Although the results of these experiments were for the most part negative, chemical weed control may still play some role in turf management. Within the past decade a great deal of advice has been offered the gardening public on the subject. Some of the recommendations that have appeared in the literature are sound and might well be taken advantage of; other are nothing more than advertising schemes. We feel, therefore, that the facts of modern chemical weed control should be made available to the amateur.

The premise upon which chemical control is based limits considerably its extensive application. In other words, if chemicals are to be effective in the control of weeds they must be selective in their effect. No chemical is specific in its toxicity to plants—any one of them capable of killing crab grass is likewise capable of killing blue grass. However, under the best environmental conditions some plants, although injured, will survive chemical treatment while others will not. This may be due to differences in leaf area rather than to physiological factors, and it is such slight differences that make partial weed control by chemical means sometimes possible. On no account should one ever attempt to replace good cultural practices and hand weeding with the use of chemicals. Sometimes they may be applicable, but only as supplementary tools.

Iron sulphate has been used effectively in controlling dandelions by what is known as "spot treatment." By that is meant placing the chemical on each individual plant. If dandelions occur in great numbers this becomes an enormous task. However, if the plants are relatively few they can easily be eliminated by punching a hole with a sharp stick in the crown of each plant and then placing in the hole a teaspoon of iron sulphate. This will kill not only

the top of the plant but the root as well, and the chemical will not damage the surrounding grass.

The elimination of weeds by means of other chemicals, without damaging the grass, isn't nearly as simple a matter as is the above. However, arsenicals and sodium chlorate may partially control chickweed provided they are used in the correct concentrations and at the proper time of year. In this climate chickweed appears in February or March. If at this time it is treated with chemicals it can be partially checked without damaging the grass seriously, but under no circumstances should treatment be made during the summer. If arsenic acid or sodium arsenate is used the concentration should be 3½ ounces per gallon of water. Sodium chlorate should be applied at the rate of 1½ ounces per gallon of water. In all cases the solution should be applied with a pressure sprayer that delivers a fine mist. Approximately 5 gallons of spray will be necessary to cover 1000 square feet. After the first treatment one should wait about ten days and then give another application if needed, the concentration of which should be reduced one half. The arsenicals are of course deadly poisons, and *sodium chlorate is highly inflammable after having once been in solution and must be handled with the utmost precaution.*

Crab grass seedlings appear at a time when it is impractical to use chemical means of control. If in the fall one wishes to kill all crab grass prior to rebuilding his lawn, this may be done with chemicals, and it is probable that treatment at this time may render some crab grass seeds non-viable.

RECOMMENDATIONS FOR ST. LOUIS

The term "lawn" is not taken to mean the same thing by all persons. Some consider it as that area in front or behind the house where the children play, or where the wash is hung to dry. Others think of the lawn as a thing of beauty, a green, well-kept carpet surrounding and intermingled with a properly landscaped garden. Obviously persons whose views differ so widely are not going to be interested in the same methods of upkeep or in the same types of lawns for that matter. As a result, it seems necessary to distinguish between *average* and *superior* lawns and to suggest methods which are appropriate for the establishment and maintenance of each.

AVERAGE LAWNS

Under this category we include that expanse of grass which ordinarily receives little treatment other than an occasional spring reseeding and the "daily sprinklings" so common throughout metropolitan St. Louis. First, it should be said that nothing better than average lawns can result from such cultural treatments, but these can be slightly extended and modified to produce far better returns without an extensive outlay of either time or money. The time of year at which average lawns should be worked with is extremely important and among home-owners this fact is almost universally overlooked. Doing the right thing is fine but unless it is done at the right time it is only a waste of effort. Let us assume that we are in possession of an average lawn and are willing to make an effort toward improving it. The time to begin that work is not in the spring *but in the fall,* in September or October. If the lawn is average it will certainly contain crab grass along with some other weeds perhaps. The natural inclination is to rake off the dead crab grass and then sow on top of the bare ground the recommended seed mixtures. In the first place, the dead crab grass should not be raked off but allowed to remain on the ground and the grass seed sown through it. This acts as a natural mulch and a substitute for a cultivated seed-bed which is so necessary for germination of grass seed. The soil, at this time, will undoubtedly be benefited by the addition of some plant food. If it is applied a complete fertilizer of an analysis 10-5-3 or 12-6-4 should be used at the rate of 20-25 pounds per 1000 square feet. This will encourage the fall growth of desirable grasses at a time when they are not competing with crab grass and weeds. In order to work the seed and fertilizer into the turf the entire treated area should be raked lightly without removing the dead crab grass. The lawn should then be thoroughly watered and not until germination is complete should the surface be allowed to become at all dry. This will require sprinkling at least twice daily. Again it should be emphasized that all this should be done in the fall of the year and not in the spring.

A most important consideration is the kind of grass seed used for reseeding. Fortunately for the gardener most grass seed must by law meet with certain standards of purity and weight. That

does not mean, however, that all seed offered for sale will do well in any one particular lawn. Grasses, like other plants, have become adapted to certain rather specific conditions of soil, moisture, and temperature and unless those are present the plants will usually not survive. Therefore, before buying grass seed it is necessary to consider the type of lawn upon which the seeds will be sown. Undoubtedly a none too fertile soil is one reason for having an average lawn, so it would hardly seem wise to purchase seed that thrives only on fertile soil and under the best cultural conditions. Actually only a few of the many available grass species will do well in our difficult climate, and unfortunately the "seed mixtures" recommended by seedsmen often contain one or more species that have absolutely no chance of surviving. It is also these species that are largely responsible for the high cost of seed mixtures compounded for use under "special conditions." For example, most mixtures prescribed for shade and semi-shade contain from 20 to 50 per cent *Poa trivialis*. This grass makes a very desirable winter lawn but it will not survive St. Louis summers even in semi-shade. *Poa trivialis* seed is imported into this country and consequently its use in mixtures increases the price per lb. A number of species of fescue (fig. 15) are also often included in mixtures, resulting almost invariably in their increased cost. The fescues, although capable of forming a beautiful turf in the North and Northeast, are extremely difficult, if not impossible, to establish in St. Louis. To sow them here is merely to throw money away. It would seem therefore that it is the wise thing to avoid purchasing seed mixtures. If a mixture is desired, and it sometimes is, buy the various grasses separately and mix them to meet the specific soil and climatic conditions under which they are to be used.

In the average lawn a number of grasses which should never be used in superior lawns may be employed to advantage. Two of these, rye grass and redtop, do fairly well under a rather wide range of soil and climatic conditions. Both germinate rapidly and neither requires the careful attention so necessary for the proper maintenance of other species. These, along with Kentucky blue grass, should be used exclusively in reseeding average lawns. Whether these three grasses are used in combination or separately doesn't make a great deal of difference since we are interested pri-

marily in a green cover and not in a turf of quality. If they are used in combination a mixture of 50 per cent Kentucky blue grass, 30 per cent redtop, and 20 per cent rye grass (by weight) is recommended. It should be mentioned that rye grass and redtop,

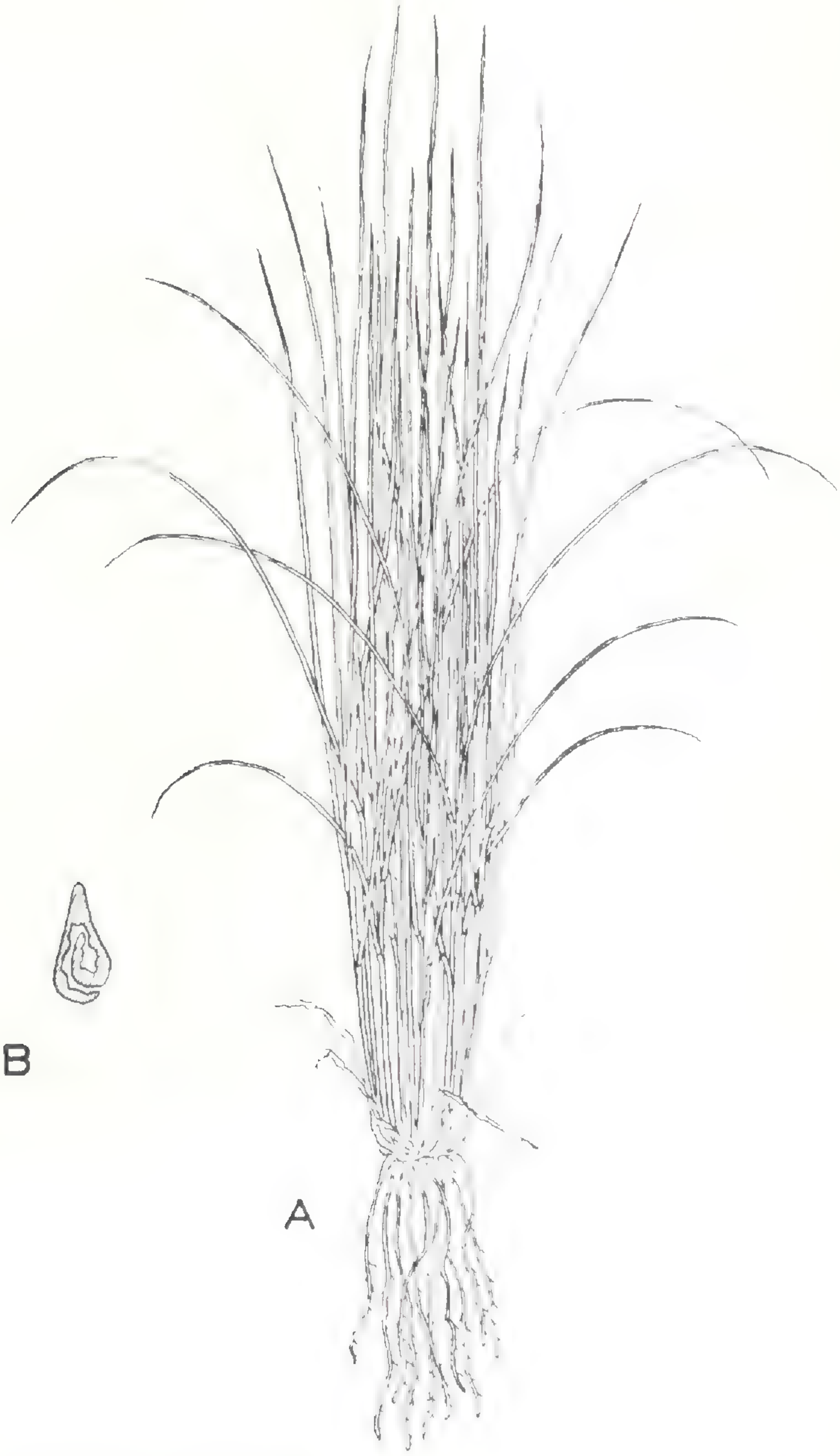


Fig. 15. Fescue, *Festuca rubra*. A, habit (× ½); B, cross-section of leaf (× 25).

whether used separately or in combination, will produce a "quick cover." Blue grass, on the other hand, is more difficult to establish, but will produce a more permanent turf once it is established. For reseeding an established turf 2 pounds of seed per 1000 square feet is sufficient. Generally speaking, this will amount to approximately 4 pounds of seed for the average lawn.

There are a number of other ways in which average lawns might be improved. For example, all lawns are mowed and for the most part rather regularly. Most gardeners, however, have always had a tendency to clip lawns as closely as the mower can be made to cut. This produces no serious results if done in early spring or late fall, but *close clipping should always be avoided during midsummer.* The average lawn-mower can be made to cut at a height of 2 or 2½ inches merely by lowering the roller as far as it will go. Contrary to popular opinion, a lawn cut at this height will look just as well as one cut ¾ of an inch, and a grass plant with a top growth of 2 inches has a much greater chance of surviving heat and drought than one with a top growth of ¾ inch. Furthermore, grass maintained at a height of 2 or more inches is far more capable of competing successfully with weeds than that which is kept in a weakened condition by continued close clipping.

Another, and in St. Louis a most important, problem facing the lawn owner is that of watering. There can be no doubt that during the average St. Louis summer lawns require some water in addition to that supplied by rainfall. This fact, we believe, is appreciated by most St. Louisans but apparently the manner in which this water should be applied has been given little, if any, consideration. If, at about six o'clock on a summer evening, one chose to walk around a block in most any part of metropolitan St. Louis where lawns are to be found he would undoubtedly find at least 75 per cent of the lawns receiving their daily sprinklings. The manner in which the water was being applied would vary little from house to house. It would be squirted on under full pressure through a nozzled hose. The person commanding the hose would, in many instances, be found at the height of a gossip session with the next-door neighbor, unmindful of the steam-rolling effect the well-meaning stream of water might be having on the few straggling grass plants that have just begun to recuperate from an

identical beating received only 24 hours earlier. Lawns would be far better off without any water than to have it given in this fashion. Such applications never wet the ground to a depth of more than one inch and many times only the surface is dampened. Under this kind of treatment crab grass will thrive, since it is a shallow-rooted plant which utilizes only that water near the surface of the soil. The grasses one should be trying to encourage (blue grass, rye grass, etc.) are much deeper-rooted; nevertheless, if water isn't available at depths of six or eight inches but is available on the surface they will naturally send their roots there for it. Once near the surface they may get one drink before they are scorched by the hot sun—two or three days of scorching and they are done for.

Undoubtedly most persons don't think of this failure as a result of the daily dampenings. If they did they would certainly change their tactics, but if so, how? In the first place, water more thoroughly and less frequently. Soak the soil to a depth of at least six inches, eight will do no harm. There are a number of methods by which this may be done, all of which are based on the principle of applying water slowly over a long period of time. This may be done with a sprinkler, canvas hose, or merely by allowing the water to run slowly from the end of a hose. The only disadvantage of the latter method is the length of time involved in covering a large area. If a sprinkler is used allow it to remain at one spot for about two hours. Then move it to an unsprinkled area for two hours, after which it should be returned to the original location for another two hours, and so on until the entire lawn is well soaked. This may require most of two days but once the soil is well soaked it will not, even in dry weather, need further watering for a week or ten days. There has always been a great deal of speculation, on the part of gardeners, as to the time of day one should or should not water grass. With the exception of bent grass, which will be discussed later, it is the authors' opinion that the time of day is of little importance. It is true that under high temperatures evaporation will be high. This, however, does not indicate any injury to the lawn but merely a waste of water.

As a summary we might briefly tabulate the several ways in which most average lawns could be improved:

1. Reseed in the fall (September or October) only.
2. Avoid the use of expensive seed mixtures.
3. Do not rake off dead crab grass. Scatter the seed through it.
4. Apply fertilizer only in fall or early spring.
5. Avoid light daily sprinklings during the summer months. Soak the soil.
6. Increase height of cut to at least 2½ inches during June, July and August.

SUPERIOR LAWNS

If superior lawns are to be superior they must receive treatment quite different from that given an average lawn. They do not just occur but must be built, and since the building must usually start at the very beginning we shall begin our discussion of it at that point. Let us assume that we are starting a lawn or that we are rebuilding it to replace a mediocre turf. The discussion which follows will apply equally well in either case. The first thing to consider is the grading. Since this is primarily a job for the landscape gardener we merely mention here that the lawn should slope slightly away from the house in all directions, just enough to permit good drainage. If possible steep terraces should be avoided. Sometimes it is possible to begin building the lawn a year prior to the time the seed is to be sown, in which case the ideal thing is to sow the area that is to become a lawn in soy-beans. These are allowed to make a season's growth and are then plowed under in late summer. If soy-beans have not been used the future lawn should, in August or early September, receive a dressing of at least two inches of well-rotted manure, after which it should be plowed or spaded to a depth of eight inches. After plowing, the ground should be thoroughly disked and then rolled or dragged. When this is completed the soil, if dry, should receive an occasional watering, but otherwise it should be allowed to lie idle until the second week of September or just prior to seeding time.

About the middle of September any weeds that have appeared should be removed and the entire surface of the soil should be covered with a top dressing consisting of one part good top soil to one part peat, to a depth of two or three inches. Also 3 pounds of nitrogen, 1½ pounds of phosphorus, and a still smaller amount

Fig. 16. Photograph of sod showing unsightly appearance of redtop among blue grass and white clover. Note the wide-leaved and sprawling habit of redtop as compared with surrounding blue grass.

of potash should be added per 1000 sq. ft. of soil area. Roughly this will amount to 20-30 pounds of complete fertilizer of an analysis of 10-5-3 or 12-6-4 per 1000 sq. ft. It is also wise to add to the soil some arsenate of lead as a means of protection against grubs and earthworms. This should be used at the rate of 15 pounds per 1000 sq. ft., mixed with equal parts of sand. The soil is then ready for cultivation and the thoroughness with which this is done cannot be over-emphasized. A finely pulverized seed-bed is essential, and in order to do this correctly most of the work will have to be done by hand-raking at a time when the soil is in a good condition to be worked. All pieces of sod and stones near the surface should be removed and cultivation should be continued until a finely pulverized and perfectly smooth seed-bed is obtained. The soil should then be well watered, and after the surface has become dry it is ready for seeding, but we should first say something of the kinds of grass to be used in superior lawns.

Only a very few of the several much talked-of lawn grasses have any place in the better lawns of St. Louis. *For a permanent turf of superior quality redtop or rye grass should never be used.* Redtop, recommended by many seedsmen and used far too often as a means of producing a "quick cover," soon becomes unsightly even in the most carefully tended lawn (fig. 16). For some unknown reason many gardeners think of redtop as an annual and consequently use it as a nurse crop. However, it is definitely perennial and becomes coarser and more vigorous each year. When sown in lawns it germinates very rapidly, usually within a week. The first season's growth makes a rather desirable, fine-leaved, light green turf. Unfortunately, in the second season it becomes a very different-looking plant with wide coarse leaves and long sprawling stems that are almost impossible to cut with a lawn-mower. Its light green color accentuates its shaggy appearance when grown in combination with blue grass.

Rye grass also is too coarse to merit any place in a superior lawn and has still further drawbacks. Its wiry leaves and stems make cutting very difficult. In midsummer it has a tendency to curl up and turn brown no matter how much water is given it. While it may have a place in average lawns, particularly for re-seeding in the spring, it is not to be recommended for the superior lawn.

For several years Bermuda grass has been discussed as a possible solution to the lawn-grass problem in St. Louis. Some gardeners use it consistently and seem to be satisfied with the results obtained. Its chief advantage lies in its heat resistance, hot sun and prolonged temperatures of 90-100° having little, if any, harmful effect. However, it has many disadvantages. In the first place, it is a southern species, and despite the claims regarding its winter hardiness it will not survive low temperatures except in favorable locations. It turns brown with the first heavy frost, or about the time that crab grass loses its color, and does not green up early in the spring. In other words, a Bermuda grass lawn is brown from the first frost in the fall until late in the spring the following year. In this respect it behaves almost exactly like crab grass, and when used alone its only advantage over that species is that it has a finer leaf and a greener color. If one were a really skillful gardener it might be possible to reinforce Bermuda with other species and thereby produce a desirable turf.

The use of *Poa trivialis* and the fescues was mentioned in the discussion of average lawns. No further comment need be made here except to say that *P. trivialis* may be used in dense shade but only in dense shade if it is expected to survive.

The very nature of the several grasses discussed above prohibit their use in superior lawns in St. Louis, and only two grasses remain which are worthy of mention. These are Kentucky blue grass and the bent grasses. The only really superior lawns in St. Louis are made up of these grasses and they probably will continue to dominate the better lawns for some time to come. In a few instances satisfactory turf has resulted from the use of blue grass and bent in combination, but there seems to be no advantage in doing this and generally a better turf will be obtained by using pure blue grass or pure bent.

Blue Grass Lawns.—Approximately 6 pounds of seed should be used per 1000 square feet of area. Before sowing, divide the seed into two equal parts and then mix each with an equal part of sand. This will increase the volume of the mixture and will result in a more even distribution of seed. After the seed is divided broadcast one half of it in one direction only, being careful to get an even distribution. This should be followed by a rather vigorous

raking in two directions. The remaining half of the seed is then sown at right angles to the first seeding. The soil should then be raked lightly in one direction, after which the entire area should be firmly compacted by rolling.

When the seed is in, the work is still far from complete, and it is at this point that a great many lawns fail. The soil should be watered as soon as the seed is sown and should never be allowed to become dry until an expanse of green entirely covers the bare ground. The manner in which the watering is done is extremely important. A very fine spray should be used with as little pressure as is possible; the surface of the soil should be moist but watering should never be so extensive that puddles will be formed. During warm weather this may mean that sprinkling will have to be done three or even four times daily, but the time spent will be well worth while. As soon as bare spots are noticeable they should be lightly raked and seeded.

After the grass has reached a height of 2½ or 3 inches it should be cut for the first time. The mower should be in a condition to cut cleanly and not pull the delicate plants from the ground. The clippings should be caught in a lawn-mower bag, or they should be raked off immediately after the mowing is completed. The number of times the young grass is mowed during the fall will of course be determined by the season. It should not be allowed to reach a height of more than 2½ or 3 inches and it should not go into the winter with more than 1½ or 2 inches of top growth. The following spring the new grass should receive the same treatment as that recommended for the average lawn. It should be remembered that the grasses are still young and are not capable of competing with weeds as successfully as are older plants. Therefore as soon as any weeds appear they should be removed by hand. This may prove to be no small task during the first summer of the lawn's development but it may save a potentially beautiful lawn which would be lost entirely if allowed to fight its own battles.

It should also be remembered that in this climate a beautiful blue grass lawn has never been established in one year. Instead, it is a matter of building it up, little by little, year after year, until this grass has reached a degree of vigor and density that will enable it to dominate its adversaries. This may be accomplished

by starting the lawn properly and then following the cultural treatments as recommended for the improvement of average lawns, namely: use fertilizer only in fall and spring; during the summer months do not sprinkle but soak the soil to a depth of 6 inches when moisture is needed; maintain the turf at a height of 3 inches during June, July and August.

Bent Grass Lawns.[1]—Various bent grasses, belonging to the genus *Agrostis,* are capable of producing more beautiful lawns than any other grass available in St. Louis at the present time. However, before deciding upon the establishment of a bent-grass lawn, the gardener should consider these factors: Bent grass is expensive, including seed, stolons, and plugs. The plants are delicate and are not capable of withstanding adverse climatic conditions without careful nursing. To manage and care for a bent lawn of 3000 square feet or more will require practically all the time of one person.

If one is to establish a lawn of bent grass the soil and seed-bed should be prepared according to the recommendations offered earlier under the heading "Superior Lawns," p. 162. The type of bent grass to be used will determine the manner of establishing the lawn. There are on the market to-day a great many varieties of bent grass, for example, Astoria bent, black bent, brown bent, brown top, Colonial bent, Columbia bent, creeping bent, English bent, New Zealand bent, Metropolitan bent, Virginia bent, Washington bent, etc. For ordinary purposes all of these may be included in one of two categories. They are either Colonial bent (*Agrostis tenuis* or varieties of this species), or Washington bent (*Agrostis palustris* or its varieties). If a bent grass is available as seed one may feel fairly sure that it belongs to the Colonial group; if it is available only in the form of plugs or stolons it is a Washington bent or one of its varieties. Although these two groups of bent grass are very much alike, they differ in some respects. Colonial bents are not as creeping as are the Washington strains; they are somewhat deeper-rooted, and the leaves are wider and lighter green. The Washington strains produce long runners and are consequently known as creeping bents. The plants are very shallow-rooted; the leaves are soft and narrow

[1] For a more detailed treatment of bent-grass lawns, see Mo. Bot. Gard. Bull. **16**: 129–143. 1928.

and of a characteristic dark green color. Since their leaves are narrow they produce a finer and more beautiful turf than do the Colonial strains. Since they are shallow-rooted they are not as heat-resistant as is Colonial bent and consequently they need more care. In selecting a bent grass, one should consider not only the difference in the quality of the turf but also the differences in time required for the maintenance of each.

If the turf is to be started from seed the same method as was suggested for seeding superior lawns should be followed, except that 3 pounds of bent grass seed per 1000 square feet is adequate. If seed is not used the lawn can be started either with plugs or stolons. No matter which method is followed the planting should be done in the fall, about the middle of September. Plugs are nothing more than pieces of turf that result from the separation of strips of sod, while stolons are runners that have been chopped up into short lengths. Stolons are sown just as one would sow seed. They are then pressed into the soil by rolling and covered with about ¼ inch of good top soil, and the area again rolled. After the stolons are planted it is necessary to keep the top of the soil moist until a green cover appears. More time is required for plugging than for planting stolons but the first method has many advantages. Before plugging, the soil should be prepared just as it would be for seeding, after which small sprigs of turf (including some stolons) are, with the aid of a trowel, planted 6 inches deep and 6 inches apart. The plugs need not be large—a piece of turf the size of two fingers is adequate. After plugging has been completed the soil should be watered and it should never be allowed to dry out during the first few months. The average gardener will often be somewhat discouraged with the growth of his bent-grass plugs during the fall and winter of the first season. They may even appear dead for quite some time after planting, but if they have been planted to a depth of 6 inches and well watered they will always survive. Growth begins early in the spring and from then on the plugs develop with unbelievable rapidity. By early summer the entire surface will be covered with a turf if it has been properly cared for. It is essential that the soil be kept perfectly weed-free until a turf is formed. This will require hand-weeding at least once and perhaps twice weekly, since the patches of bare ground between the plants are ideal for weed invasion.

After a dense turf has developed weed elimination becomes negligible. There are, nevertheless, other cultural practices that must be executed precisely if bent grass is to succeed, the more important of which will be discussed briefly as follows:

Watering.—Bent-grass lawns require more frequent watering than any other kind. The plants are shallow-rooted, and if the top soil is allowed to become dry they soon become withered and eventually die. During summer months watering may be necessary every day or at least every second day. Watering from an open hose is to be avoided; a sprinkler is very much better. The time of day at which bent grass should be watered is also important. A turf that is wet at night is much more susceptible to fungus diseases than a dry one. Therefore it is wise to water early in the day so that the surface of the turf will have dried off by evening.

Top dressing.—The stolons (runners) of bent grass creep horizontally at or very near the surface of the soil. From these stolons new leaves and roots develop so that a mature sod is nothing more than a mass of roots, stolons, and leaves lying almost on top of the ground. The new stolons do not penetrate the soil as they develop, but for the most part creep on top of the existing mat. It is therefore essential that if they are to be protected from the sun's rays they must frequently be covered with soil. Unless this is done they soon dry out and the lawn assumes a brown, withered appearance. A number of mixtures have been used as top dressing for bent grasses, but *relatively weed-free* top soil (if available) is unexcelled for this purpose. The dressing should be applied about four times during the year; in the spring the surface should be covered to a depth of about ½ inch; two lighter applications of ¼ inch should be added during the summer; and the heavy application repeated in the fall. The soil should be added just after the lawn has been mowed and it should always be worked well into the turf with a broom or fan-rake. If at any time during the season small spots show up in the turf which appear to need top dressing, they should be taken care of immediately. If soil is not available a mixture of three parts peat moss to one part sand may be used successfully. It should be emphasized that, more than any other one factor, frequent top dressings are responsible for the outstanding beauty of good bent-grass lawns;

and in most instances the poor bent lawns are poor because of insufficient top dressing.

Fertilizers.—Aside from top dressings, bent grasses should receive an application of complete fertilizer semi-annually. A fertilizer with an approximate analysis of 10-5-3 should be applied at the rate of 20 pounds per 1000 square feet during the latter part of September and again in early March. While an analysis exactly as that given above is not necessary, it should have approximately twice as much nitrogen as phosphorus and a lesser amount of potash. If the nitrogen content is greater or less than 10 per cent the total amount of bulk applied should be adjusted so as to make available 2 pounds of nitrogen per 1000 square feet.

Diseases.—Two fungus diseases are rather common in the bent grasses of the St. Louis area. These are commonly known as "brown patch" and "dollar spot," and both show up during the summer, particularly when the humidity is high. They first appear as round, bluish-gray spots and after one or two days the grass becomes brown and dies. Unfortunately there are no means of preventing the occurrence of these diseases but they can be effectively controlled through the use of arsenic-mercuric compounds. One which has proved satisfactory on several lawns is sold under the trade name of "Calo-Clor," and directions for using it are included with the container.

Cutting.—Bent grass, unlike other lawn grasses, must be clipped rather short (1½ to 1¾ inches) throughout its growing season. This may necessitate mowing once, twice, or even three times weekly, depending upon the growing conditions. Bent grasses will not survive being cut back after they have reached a height of three inches or more. Therefore, if one wants a grass that can be forgotten while he is on his vacation he should never consider the bents.

Weeds.—The same weeds infest bent grass as other types of turf, and the only means of eliminating them is by hand. *Chemical weed eradicators are disastrous to bent grass and should never be used.*

William L. Brown,
Edgar Anderson.

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NOTICE

ATTENTION is called to the recently issued "Spring Flora of Missouri" by J. A. Steyermark. About fourteen hundred plants blooming in Missouri and adjoining states are described and most of them illustrated. Designed primarily for nature-lovers, scouts, amateur botanists, etc., emphasis is placed on the common name; also, an attempt is made to write the descriptions in simple untechnical language so that, with the help of the keys and the illustrations, identification of spring-blooming flowers should not be difficult. The book is cloth-bound and comprises 590 pages, 163 plates, and 444 line drawings. For sale by the Missouri Botanical Garden. Price $3.00.

Missouri Botanical Garden Bulletin

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SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date to the death of Mr. Shaw, in 1889, the Garden was maintained under the personal direction of its founder, and while virtually a private garden it was, except at certain stated times, always open to the public. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was designated by Mr. Shaw as its official title and in his will and all of his writings he specifically referred to it as the "Missouri Botanical Garden." By a provision of Mr. Shaw's will the Garden passed at his death into the hands of a Board of Trustees. The original members of the Board were designated in the will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provison of the will, the immediate direction of the Garden is vested in a Director, appointed by the Board of Trustees. The Garden receives no income from city or state, but is supported entirely from funds left by the founder.

The city Garden comprises 75 acres, where about 12,000 species of plants are growing. There is now in process of development a tract of land of over 1,600 acres outside the city limits which is to be devoted to (1) the propagation and growing of plants, trees, and shrubs, designed for showing either indoors or outside, at the city Garden, thus avoiding the existing difficulties of growing plants in the city atmosphere; (2) gradually establishing an arboretum as well as holding a certain area as a wild-flower reservation, with the idea that possibly at some future time this may become the new botanical garden.

The Garden is open to the public every day in the year except New Year's Day and Christmas—week days from 8:00 a. m. until sunset; Sundays from 10:00 a. m. until sunset. The greenhouses are closed every day at 5:00 p. m.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Place, on the Sarah car line (No. 42). Transfer south from all intersecting lines.

1. PEONIES IN THE GARDEN OF MRS. HAYWARD NIEDRINGHAUS
2. PEONIES IN THE LANDSCAPE AT THE MISSOURI BOTANICAL GARDEN

Missouri Botanical Garden Bulletin

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PEONIES

A flower border is not complete without some peonies. Few perennials are as colorful in May, yet remain in such good condition throughout the year. Compare, if you will, the massive blooms of an oriental poppy with those of a peony. In splendor of color they are on a par in the spring, but the foliage of the poppy soon turns brown and disappears while the peony foliage provides a bold mass of rich green as a background for later flowers. Tastes differ and, although to some people the large peony flowers seem coarse, beauty and grace may be found in the peony species and in the single and Japanese varieties. There is not such a great deal of difference between the single and Japanese peonies for both have one or two rows of petals, but in the Japanese type the central cushion is composed of numerous tiny petals instead of stamens.

This is the time of the year to transplant peonies and to acquire new varieties. After the plants become dormant in September they may be lifted, divided, and replanted. If, for some reason, this work cannot be done in the fall it may be done in March or early April, before the peonies have made much growth. Before planting, one must naturally consider the site, the soil, and the amount of space required. In time single peony clumps will average four feet in diameter, and because of this large growth it is well to keep them to the rear of the flower border. The plants grow best in full sunlight but they will tolerate a little shade. If the flower border has been in existence for several years and the plants in it have been growing satisfactorily, there is no need to be too much concerned about the type of soil for the peonies. It should be borne in mind, however, that they remain in the same

location for many years and a little extra effort in the preparation of the soil will insure good peonies for many years to come. A hole at least eighteen inches wide and deep is none too large for each plant. The top soil should be removed and the second layer thoroughly broken up with a spading fork. If the clay is extremely gummy, about a pint of pulverized limestone should be added to each hill. Subsoil should have some humus mixed with it. For this purpose humus from the compost pile or peat moss may be used. Although the European supply of peat moss has been cut off, domestic peat is now becoming available. When the soil is returned to the hole it should be firmed so that when the peony roots are planted they will not settle.

The moving of a large peony clump requires a lot of energy in digging and much patience and care in separating the roots. When first dug the large fleshy roots are extremely brittle but in a few hours they lose their rigidity and are more easily handled. The soil, which is so tightly held by the roots, is best dislodged with a stream of water from the hose, taking care not to bruise the peony eyes. The wrong way to divide an old peony clump is to cut it in half or in quarters and then replant the parts without removing any of the large roots. Plants from such divisions depend upon the old roots for nourishment and seldom bloom. Cutting the clumps into smaller divisions and shortening the roots to four to six inches from the eyes forces the production of new roots. This is very stimulating and causes plants to grow much better than large clumps with all of the old roots intact. Many of the large roots may be removed with pruning shears before the plants are divided. An asparagus knife, which may be obtained from the seed stores, is an excellent tool for dividing the roots. It is long and slender and easily forced between the tightest roots. With a few taps of a hammer or mallet an opening may be made in a large clump, and once that is accomplished the pieces will separate easily. The roots of an old clump are sometimes so tight that it is necessary to split it before any good divisions may be obtained. Peony growers concede that a good division should have from three to five eyes and several good roots.

Peonies should be planted with the eyes two inches beneath the surface of the soil. If the soil is loose the roots will settle with it and when they are too deep the plants fail to bloom. It is advisable

1

2

TREE PEONIES

1. Banski.
2. Tama-jishi.

1

2

3

4

TYPES OF PEONY FLOWERS

1. Single—The Bride.
2. Japanese—Mikado.
3. Double—Myrtle Gentry.
4. Botanical—*Paeonia tenuifolia*.

to cover the peonies the first winter with a mulch of straw or coarse leaves. This mulch should be applied in late November and removed the latter part of March.

Peony eyes begin pushing through the soil in early spring and grow very rapidly during April. At first the red and bronze stems appear as mere sticks but ten days later the leaves unfold, revealing the tiny buds in the center of each stalk. By early May the plants have attained their maximum growth and from then on the flower buds develop. Just before the buds show color they are covered with drops of sugar water, at least so the ants think, for they love it. This is the first worry of the novice for he is sure the ants are ruining his plants. He should not be alarmed, however, as the ants will do no harm and are only eating the sap.

Most varieties of peonies produce lateral buds. When exhibition flowers are desired, or when the flowers of the double varieties are sure to be weighted down if all are left to open, these side buds should be removed as soon as they can be handled. The terminal bud will then develop into an exceptionally fine flower. Single and semi-double varieties, or such as are used in the landscape, may be left to grow naturally.

Peonies may be fed in the spring before the plants grow too large. A handful of balanced fertilizer per plant is sufficient food for one season. The fertilizer is best applied in a ring around the plant, keeping it at least eight inches away from the stems. The stirring of the soil several times during the spring benefits the plants and permits the rains to penetrate. Later on the foliage becomes so dense that light showers never moisten the soil beneath. During extremely dry weather the peonies should be thoroughly watered to prevent them from wilting.

That portion of the peony above ground is seldom attacked by insects. However, in certain varieties the fibrous roots sometimes contain many small knots, or the larger roots may be swollen. This condition is the result of a tiny wire worm, called a nematode. Badly infested roots should be destroyed. If new peonies are to be planted in the region where the old ones grew, fresh soil should be used. On a strong root system nematodes seldom become so numerous as to cripple the plant and prevent it from blooming. When weak plants are lifted it may be found that the roots are badly decayed and covered with a black mould. This disease is

termed root-rot. There is no known cure and no attempt should be made to salvage portions of such plants. When peonies are deeply planted in poorly drained soil troubles of this kind may be expected. Botrytis blight is another disease which attacks peony plants and is commonly recognized by the dark brown buds which fail to develop. When this disease is serious the plants should be sprayed with Bordeaux mixture or dusted with copper-lime dust. This should be done as soon as the shoots appear in the spring, with two or three successive applications at weekly intervals. Bordeaux powder is easily obtained but copper-lime dust is only sold by a few dealers, particularly lily specialists. The disease spores remain in the old stems and leaves during the winter, and for that reason all peony stalks should be cut at the surface of the ground in October and burned.

In peony catalogues the varieties are usually grouped under the headings of double, single, Japanese, hybrid, tree peonies and species. Prices range from fifty cents to several dollars. Varieties are listed as early, mid-season, or late, and frequently the rating of the American Peony Society is given. One naturally would suppose that a variety that rated 9.9 (10 being perfect) would be the finest peony to buy. This is not the case, however, as varieties do not grow uniformly well in all parts of the country and some ratings favor the exhibition table more than the garden. Late-blooming peonies should not be planted in this locality as varieties that are still in bud in late May fail to open properly. Some peonies have exceptionally beautiful and fragrant flowers but weak stems, and these are certainly not good garden plants. Some of the weak-stemmed, double varieties are perfect when they open in fair weather, but after one shower bend far over and never resume their original position. The single, Japanese, and the dwarf double varieties can stand wind and rain better than the tall double varieties and are to be preferred for garden and landscape use. Peony fanciers will want to grow many different kinds but they should be prepared to stake the weak ones.

All of the afore-mentioned peonies are termed "herbaceous," which means that they are not woody and die down to the ground each fall. Tree peonies differ from the herbaceous kinds in that they have woody stems which grow very slowly and ultimately reach a height of from two to four feet. They shed their leaves

1

2

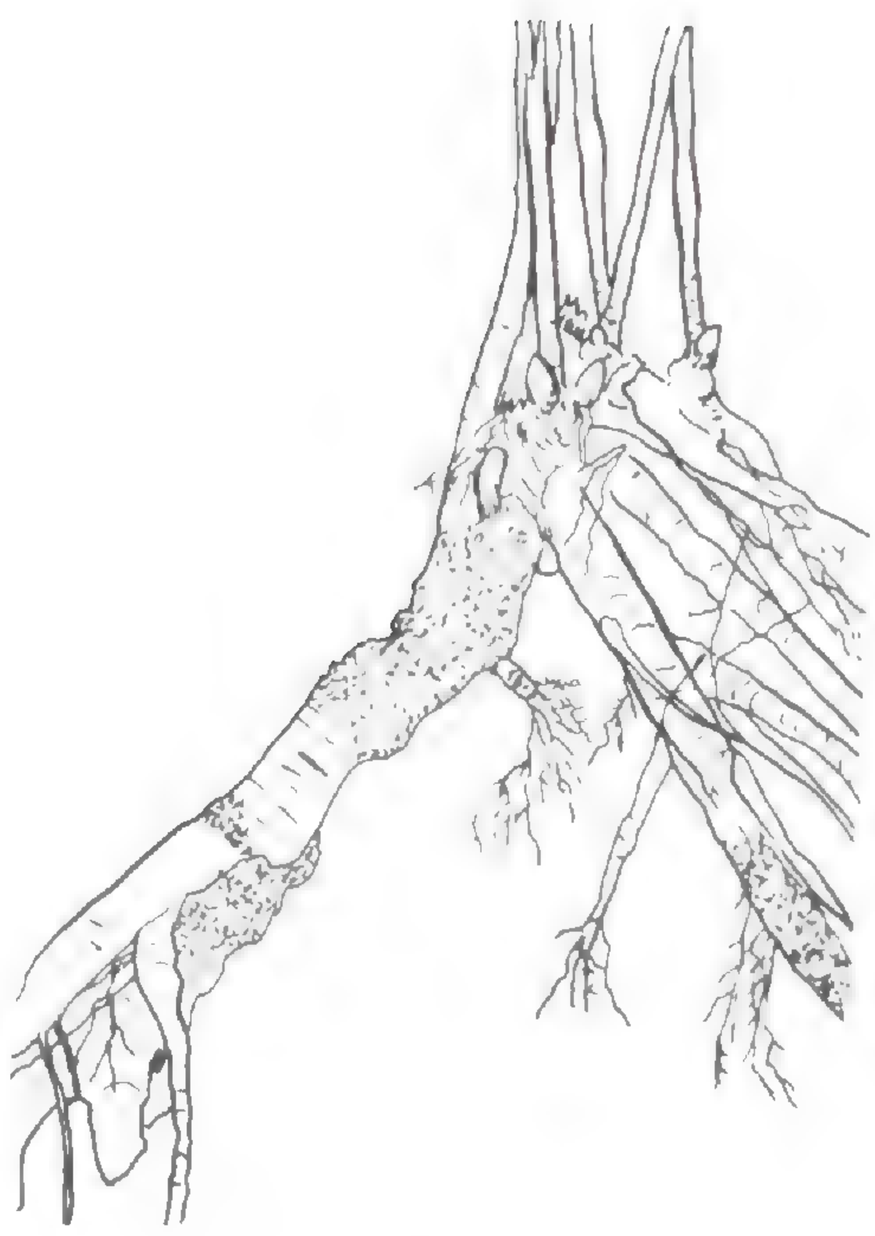
3

4

DIVIDING A PEONY CLUMP

1. Roots and Soil.
2. Washing Roots.
3. Dividing Roots With Asparagus Knife.
4. Three-Eye Division.

1



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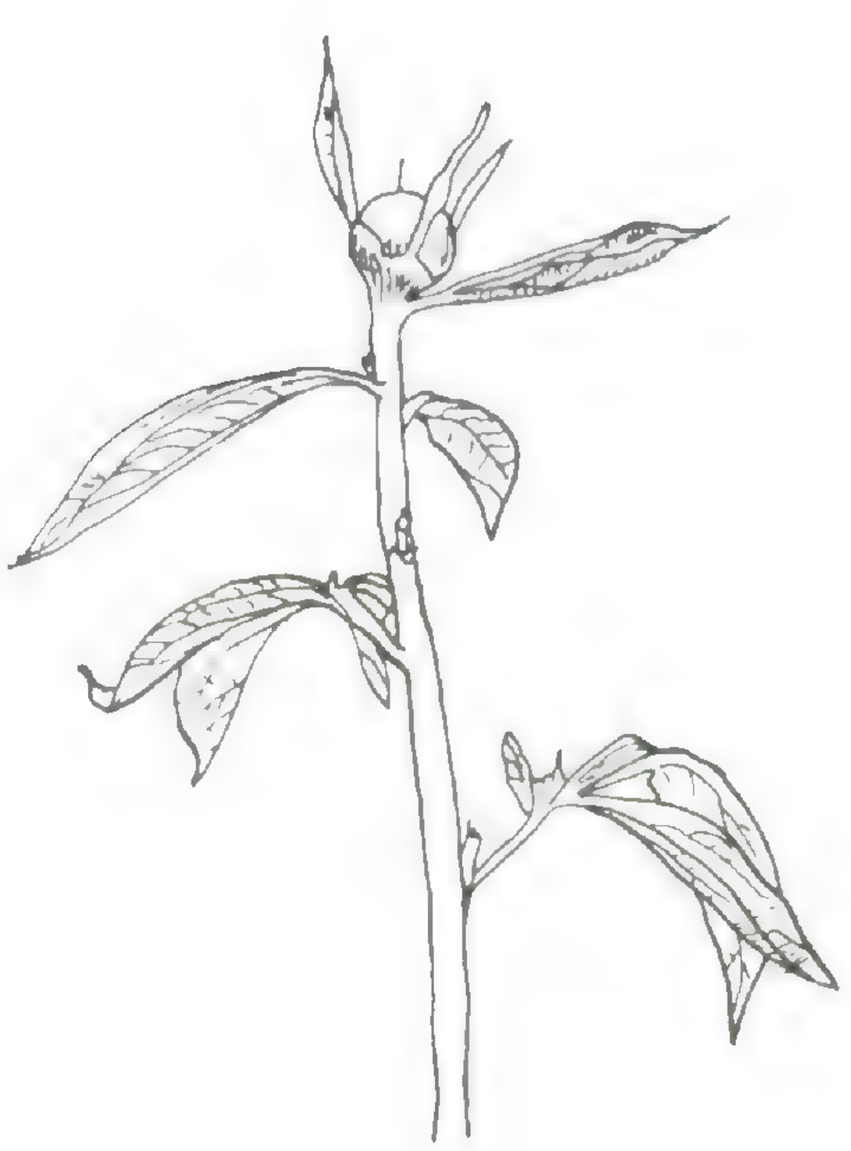

4

1. ROOT KNOT. 2. ROOT ROT.
3 and 4. BEFORE AND AFTER DISBUDDING.

each fall but the ends of the stems contain the buds which continue the growth the following year. The flowers are large and beautiful with a color range through white, pink, red, lavender, and rich yellow. Tree peonies propagate slowly and this accounts for their higher price. A good time to plant them is in the fall when they are dormant. The younger plants are grown in pots so it is possible to plant them any time during the spring. Tree peonies were formerly imported from Europe and Japan, but now numerous varieties are being offered by American peony specialists. Mr. Josiah Whitnel, of Signal Hill, Illinois, has probably assembled the best collection of tree peonies in the Middle West. Most tree peonies bloom in late April and early May. They are perfectly hardy. The only time that they might be injured is during an April freeze. On April 9, 1938, a wet snow all but flattened the peonies in this region but somehow they survived the ordeal. Such cold snaps do not occur every year but a gardener does feel relieved when the capricious April weather has passed.

The list of peonies which concludes this article is selected from the 160 varieties which have been grown and compared in our peony collection. It is not a large list but it will serve as a guide in selecting dependable peonies for this region.

SINGLE PEONIES

Harriet Olney—soft rose
Krinkled White—follows Le Jour
Le Jour—a very fine white
L'Etincelante—bright pink
Madeleine Gauthier—light flesh-pink
Marguerite Dessert—white, powdered with rose-pink dots
Perle Blanche—tall white, stiff stems
President Lincoln—a fine tall, late red
Pride of Langport—pale, rose-pink
Vera dark maroon-crimson

JAPANESE PEONIES

Ama-no-Sode—rose-pink
Departing Sun—light crimson
Isani Gidui—the finest white
Mikado—dark crimson. A good landscape variety

DOUBLE WHITE TO BLUSH-WHITE PEONIES

Avalanche—a good late white
Ball O'Cotton—medium height
Baroness Schroeder—a late flesh-white
Duchesse de Nemours
Festiva Maxima
Frances Shaylor
Frances Willard
Kelway's Glorious
La Lorraine
Le Cygne—good in some years
Mme. Jules Dessert—a late dwarf white
Myrtle Gentry
Nymphaea

DOUBLE PALE TO ROSE-PINK PEONIES

Albert Crousse medium height
Georgiana Shaylor—light rose-pink
Ginette—dwarf late pink
June Day
Lady Alexandra Duff
La Perle—lavender-pink
Lillian Gumm—late
Mabel L. Franklin—flesh-pink
Mary Woodbury Shaylor—dwarf flesh-white
Octavie Demay—pale pink, almost white
President Wilson—tall, rose-pink
Reine Hortense
Souvenir de Louis Bigot
Venus—tall, rose-pink

DOUBLE CRIMSON AND RED PEONIES

Adolphe Rousseau
Benjamin Franklin—tall
Felix Crousse
Karl Rosenfield
Mary Brand—late
Philippe Rivoire
William F. Turner—tall red
Winnifred Domme

P. A. K.

TWO OZARK WILD FLOWERS FOR THE FALL GARDEN

Late September is a difficult period for many St. Louis gardens. Nights are beginning to be cool and the brilliant annuals which gave color in the first part of the month are drying up and slowing down for the winter. In St. Louis, though, the days are still warm, and plants which a little farther north are the glory of the fall garden do not feel at home here. Then, too, September is such a chancy month in St. Louis, one year bone-dry and the next one soaking wet, that few perennials can be depended upon year in and year out. To be sure, *Sedum spectabile* is available in several varieties but by rights it belongs to the first fortnight in September and cannot be counted on for good bloom after about the twentieth. The Korean chrysanthemums are nearly always excellent, if one knows how to care for them, but they seldom provide a really fine display before the tenth of October.

If St. Louis gardeners did but know it, there are two native wild flowers which bloom at this time, wild flowers, moreover, which profit by being moved into the perennial border and show to even better advantage there than they did on the dry Ozark hillsides from which they came. They are so little known that neither has a common name but we shall remedy that omission by calling *Aster anomalus* "The Ozark Aster," and speak of *Allium stellatum* as "The Rosy Allium," leaving to those already in on the secret just exactly what scandal is indicated by the name of Allium.

THE ROSY ALLIUM

The rosy allium grows from a bulb about the size of a small tulip bulb and gives rise in late spring to a sprawly rosette of leaves which are not too attractive in the garden but which can easily be more or less hidden in a perennial border. These tend to die down during the summer, and in late August they are succeeded by the flowers which rise in a little sunburst cluster, like an opening sky-rocket. They take on color as they unfold, changing from a chalky white to a pinky silver, deepening to bright rose pink as the florets eventually open. Ridgway calls the color "mallow pink," and technically it is very like the pink of certain mallows, but the texture of the flowers is so different that the name is not too appropriate. Mallows have a linen-like texture when seen in the garden, while alliums are waxy and their flowers have more the look of being made out of waterproof silk or rayon. A group of bulbs does not usually burst into bloom all at the same time and there is a pretty play of color between the lighter pink of the buds and the deeper tones of the fully opened flowers.

The rosy allium is not at all choosy as to the soil in which it is grown. It does not like being overcrowded by other plants throughout the season but it does not mind spring bulbs (which are on the way out before it is on the way up), and if given decent care will grow and increase in either full sun or semi-shade. In the Ozarks it grows for the most part in very rocky places, at the side and along the base of cliffs, on dry rocky hillsides, particularly at the edges of bare spots where it has the shade at its back but full sun in front. In the Missouri Botanical Garden Arboretum at Gray Summit it grows in great abundance, and from late August to mid October its rosy pompons will be seen scattered here and there very generally along the woodland trails and massed by the thousands under the red cedars which line the glades. It could probably be raised from seeds in a year or so. It sets abundant crops in my garden if the flowers are not picked, and the distinctive little hump-backed seedlings will often be found coming up in the garden in the early summer. It is already listed for sale by a few dealers in native plants and by rock-garden nurseries but it deserves much wider use. There is a great deal of variation in flower size and color from plant to plant, and it is quite probable

that with a little selection particularly beautiful garden varieties could be developed.

One fact has probably contributed more than any other to the lack of appreciation of this really beautiful plant. The flowers have a rather attractive scent but if the foliage is crushed in the hand it will be found to smell strongly of onions, and botanists classify it in the same group with them and their garlicky kin. Few gardeners have the courage to grow onion blossoms in their perennial borders even if they like the flowers, so if by any chance you do grow the rosy allium in your flower border it is much better to call it by that name and let visitors judge it on its own merits as a garden flower.

THE OZARK ASTER

The Ozark aster is really well entitled to that name, since it is very commonly found on dry hillsides in southern Missouri but is unknown elsewhere except as it spills over into Oklahoma at one end of its range and spreads up to central Illinois at the other. When Dr. George Engelmann first described it he appropriately named it "*Aster anomalus,*" for there is no other species of Aster at all similar. It combines the large blooms and shaggy flower-heads of the New England asters with the long heart-shaped leaves which ordinarily go with the little misty gray-blue sorts. It has, in addition, a strange leathery texture, as do various other kinds of plants which are peculiar to these dry rocky hill-lands. The flowers are not only large but are of a beautiful and most arresting shade, a blue with an undertone of pink, or a pink which is almost a blue. It combines most attractively with the bright pink of the rosy Allium and keeps a clear fresh look in the fall garden. Ridgway defines the color as "light mauve," which is a good name for it if one remembers that it is a clear mauve and not a muddy one. It is indeed the kind of mauve which Whistler said was "pink trying to be purple."

The Ozark aster is only one of around thirty species of that genus which are native to Missouri. However, it is of all these the one which is most satisfactory for the perennial border. There has been a great deal of nonsense in the horticultural press about the way in which our native asters have been neglected in America

to become in England the glory of the fall garden and raised to the dignity of being "Michaelmas Daisies." The unwarranted conclusion is usually drawn that if we were only such good gardeners as the English we would have developed and appreciated these lovely flowers which are native to our own doorsteps. If these writers had tried to grow American asters in middle-western gardens, they would have written quite differently. At one time or another I have grown about twenty American species, as well as numerous English and American varieties, and have also grown a few of them in England. The truth of the matter is that as a group they are much more satisfactory flowers for English gardens than they are for American ones and are much easier to grow there than here. In the first place, like many flowers in the daisy family, their size varies with the latitude. When I first saw the same varieties in England which I had been raising in Missouri I did not recognize them because they were so much larger. I actually did not think that *Aster tataricus* was an aster at all. Its flowerheads were so very large that it looked like a new kind of tall chrysanthemum. In the second place, cultivated plants are nearly always easier to grow away from their wild relatives because then fewer pests and pestilences spread from the wild populations into the cultivated stands. Many Michaelmas daisies lose their lower leaves and in other ways look quite unkempt when grown in Missouri gardens. Even old reliable varieties like "Climax," which can be grown with considerable success in New England, die out in a year or two in St. Louis unless they are very carefully handled.

If we are to have many reliable varieties of Michaelmas daisies in St. Louis we must build them from the ground up and originate kinds which can stand hot summers, erratic autumns, and smoky winters. Several of our native species grow well when moved into a town garden, but few of them look as attractive there as they did in the woods. *Aster patens,* for instance, loses what little delicacy it possessed as a wild plant and becomes a criss-cross mess of interlacing branches. *Aster turbinellus* is fairly attractive and so are a few dwarf strains of *Aster Drummondii,* but the only native species which I have found to be generally reliable is *Aster anomalus.* Moved into the garden it retains its strange leathery

texture but it becomes no more weedy in habit than in the oak-maple woodlands where it is native. It responds by being many times as floriferous, and instead of a few stray branches lined with blossoms there are great mounds of bloom. Anyone who has grown hardy chrysanthemums will know how to stimulate the plants to show to best advantage by pinching back the main stems in the very early summer to make them branch out, and repeating the process once or twice during the summer. Like chrysanthemums, the Ozark aster seems to be a strong feeder and does its best in the perennial border when reset about every second year.

In the wild flower gardens at the Missouri Botanical Garden Arboretum and elsewhere in the Ozarks, there is a great deal of variation in *Aster anomalus*. Some of the plants have large flowers, some of them small ones, the ray-flowers may be straight, or wavy, or even fringed at the tip, and vary greatly in number. With a little patience it should be possible to develop a number of excellent garden varieties.

E. A.

BEWARE THE DROUGHT

Almost annually since 1932 the BULLETIN has discussed some phase of the drought problem. It might seem that such an annual warning is becoming a habit. At the same time we have but to recall the many specimens of evergreens sent to the Garden last spring in which dry weather was diagnosed as either the primary or secondary cause of death. It is safe to assume that many gardeners receiving such information felt that it was incorrect. Most people had practiced some sort of irrigation, and everyone remembered the deep and lasting snow blanket of the past winter. However, while the snow was deep it added little water to the soil when it began to melt. During some construction work at the Arboretum, when watching the slow evaporation of the snow, it was observed that, while the deep snow formed a grand mulch protecting plants from the cold, most of the water evaporated in the brilliant sunshine.

Rainfall records show that there is an accumulated deficiency of twelve inches as of September 1 for this year. But rainfall rec-

ords are but one portion of the picture. The *distribution* of that rain is much more important. For instance, the shortage of rain toward fall is especially serious since it is at this time that trees store water against the future season. During late summer they also make much new root growth. There is considerable experimental evidence indicating that there is root activity so long as the soil temperature remains above 46° F., and freezing temperatures in the lower soils rarely occur in this region before mid-January.

Newly transplanted trees and shrubs suffer most, since artificial irrigation is rarely practiced long enough and there is seldom time or opportunity for the injured roots to heal and regain intimate contact with the soil. A transplanted tree will remain green only until it has exhausted the reserve of water within the trunk. Therefore, such trees look well until the first week of hot dry weather and then they seem to collapse almost over night. Irrigation which is begun at that time is altogether too late. To be of any value to trees and shrubs, irrigation must wet the soil for about three feet, or deeper if many roots are found below that level. For instance, it was necessary to pump about five inches of water on to the Mausoleum enclosure at the Garden. The soil in this area, and through most of the gardening regions of St. Louis and county, will hold approximately one inch of rain for each foot in depth of soil. If the soils are very deep and the roots extend some five or six feet down to rock or an impervious clay, it is apparent that "just letting the sprinkler run" will never supply a tree with water. Perhaps the most important time in which to supply additional water is during the early fall and winter.

A very heavy shedding of the older coniferous foliage, which is a common sight throughout the county at the present time, is due largely to the dry weather this fall. Dry weather is infrequently the sole cause of death in mature trees. Usually after a tree becomes desiccated many otherwise harmless diseases and insects are able to gain a foothold. This, in a large measure, explains the startling increase in the number of wilt diseases found in elms, horse-chestnuts, and now making their appearance in the white oaks.

The symptoms of drought are not always easily detected. They are often confused with "winter injury," and there are usually

other contributing factors. As a result of this past season's drought, we may anticipate much injury from cold. The species and varieties which have proven hardy in other years may be killed back seriously. Very large trees, and especially the conifers, usually store within their trunks sufficient moisture to carry them over several dry seasons, but eventually insects and diseases gain a foothold and water alone will not remedy the situation.

A. P. B.

NOTES

In commemoration of the date of Henry Shaw's death, a wreath of orchids was placed on his tomb, August 25.

Dr. George T. Moore, Director of the Garden, in a broadcast over Station KWK, October 8, discussed "Orchids" in general and the Veiled Prophet Queen's orchid bouquet in particular.

Mr. Russell J. Seibert, Washington University Fellow in Botany, has been on an expedition of the U. S. Department of Agriculture since July. He is expected to return in January.

Mr. A. P. Beilmann, Arboriculturist to the Garden, was one of a small group who were invited to conduct a plant clinic during the National Shade Tree Conference, at Detroit, August 30.

Mr. Russell J. Seibert, Washington University Fellow in Botany, is the author of a paper which appeared in the September number of *Tropical Woods* (No. 63, pp. 7-8), entitled "New Names in Cybistax and Tabebuia."

Prof. Robert Stratton, Associate Professor of Botany and Plant Pathology, Oklahoma Agricultural & Mechanical College, Stillwater, spent the summer at the Garden library and herbarium, in a study of the Leguminosae.

The August number of *Gardeners' Chronicle of America* (**44:** 237-239) contains an illustrated article, "A Cactus Hunt in Mexico," by Mr. Ladislaus Cutak, in charge of Succulents at the Garden.

Mr. Ladislaus Cutak, in charge of Succulents at the Garden, gave an illustrated lecture, "Plants of Old Mexico," before the St. Louis Horticultural Society, October 4; and on "Cacti and Succulents," before the Des Moines Garden Club, Des Moines, Iowa, October 10.

Mr. L. P. Jensen, Manager of the Arboretum, gave a talk before the members of the Tenth District of the Federated Garden Clubs of Missouri, at Meramec State Park, September 27, on "Roadside Development." On this occasion he was presented with a life membership in the Federation.

In the Carnegie Institution of Washington Publication No. 522, issued in June, 1940, Dr. Robert E. Woodson, Jr., Assistant Curator of the Herbarium, has contributed "The Apocynaceae of the Yucatan Peninsula," and Mr. Russell J. Seibert, Washington University Fellow in Botany, "The Bignoniaceae of the Maya Area."

In addition to the newspaper reviews of Steyermark's "Spring Flora of Missouri," the following publications have recently reviewed the book: *Garden Forum,* May, 1940; *Garden Life,* June, 1940; *Field Museum Notes,* June, 1940; *Rhodora,* June, 1940; *American Midland Naturalist,* June, 1940; *American Botanist,* July, 1940; *Missouri Historical Review,* July, 1940; *Scientific Monthly,* September, 1940.

The following articles from the MISSOURI BOTANICAL GARDEN BULLETIN by Dr. D. C. Fairburn, Horticulturist to the Garden, have been reprinted recently: "Mealy Bugs," in the April number of *The Shade Tree* (Vol. 13, No. 4); "Some Common Plant Pests and Their Control," in the August number of *Real Gardening* (**3:** 56-63); "Forcing Hardy Bulbs," in the September *Garden Digest* (**12:** 19-23); "African Violets," in the October *Garden Digest* (**12:** 42-43).

The October number of *Real Gardening* (**3:** 67-75) contains a digest of the Garden BULLETIN on "Chrysanthemums," by Mr. Paul A. Kohl, Floriculturist to the Garden, the title having been changed to "Chrysanthemums from Start to Finish." Mr. Kohl also has an article in the October number of *Gardeners' Chronicle*

of America (**44:** 307), entitled "Growing and Displaying Chrysanthemums."

The September number of the ANNALS OF THE MISSOURI BOTANICAL GARDEN was issued in September, and contains the following papers: "Supplementary Notes on Salvia: Audibertia," by Carl C. Epling; "*Mertensia Drummondii* (Lehm.) C. Don," Louis O. Williams; "Contributions toward a Flora of Panama. IV. Miscellaneous Collections, chiefly by Paul H. Allen," Robert E. Woodson, Jr., and Robert W. Schery; "An Attempt to Record Internal Tree-Trunk Pressures," August P. Beilmann.

Early in August, Messrs. Joseph and Ladislaus Cutak, in charge of Exotics and Succulents at the Garden, respectively, made a tour of the southeastern states, spending a week in Florida where they visited commercial gardens, nurseries and private collections of orchids, cacti and other exotic plants. Such notable institutions as the McKee Jungle Gardens, the Florida Cypress Gardens, Fairchild Tropical Garden, U. S. Plant Introduction Garden, Florida State Agricultural Experiment Station, Colonel Robert Montgomery's Estate, Shore Acres Nurseries, St. Leo's College, and many others were inspected. Some cacti and seeds were collected and an attempt will be made to establish these in the Garden.

Among the visitors to the Garden during the last several months were: Mr. LeRoy H. Harvey, Research Assistant, Botanical Gardens, University of Michigan, Ann Arbor; Major W. Knaggs and Sir George F. Huggins, of Trinidad, British West Indies, both orchid fanciers; Mr. George B. Rossbach, graduate student, Leland Stanford University, Calif.; Mr. John B. Lager, orchid grower, of Summit, N. J.; Dr. F. W. Pennell, Curator of Plants, Academy of Natural Sciences, Philadelphia, Pa.; Mr. Lewis M. Abrahms, orchid grower, of Glencoe, Ill.; Mr. Julian F. Smith, Associate Director Hooker Scientific Library, Central College, Fayette, Mo.; Mr. Louis Fourt, graduate student in genetics, University of Missouri, Columbia; Mr. Ralph Emerson, Instructor in Botany, University of California, Berkeley; Dr. F. A. Barkley, Instructor in Botany, University of Montana, Missoula; Dr. F. L. Wynd, Assistant Professor of Botany, University of Illinois, Urbana; Dr. Paul C. Mangelsdorf, Professor of Economic Botany,

Harvard University, Cambridge, Mass.; Dr. Louis Wheeler, Instructor in Botany, American University, Washington, D. C.; Dr. Leon Grodsinsky, Division de Fitopatologia, Ministerio de Agricultura, Buenos Aires, Argentina; Dr. Robert W. Webb, Principal Cotton Technologist, Bureau of Agricultural Economics, U. S. Dept. Agr., Washington, D. C.; Dr. Maxine Larisey, Assistant Professor of Biology, Judson College, Marion, Alabama; Mr. Nelson M. Wells, Landscape Architect, Hastings-on-Hudson, N. Y.; Miss Rose B. Phelps, Associate in Library Science, University of Illinois, Urbana; Dr. Carlos A. O'Donell, of the Instituto Lillo, Tucumán, Argentina; Mrs. F. F. Davis, Botanist, U. S. Golf Association, Green Section, Washington, D. C.; Dr. Elzada U. Clover, Instructor in Botany, and Assistant Curator, Botanical Gardens, University of Michigan, Ann Arbor; Miss Lois Jotters, graduate student in botany, University of Michigan; Miss Helen Bartlett, Librarian Junior College & High School, Parsons, Kansas; Dr. George B. Happ, Assistant Professor of Biology, Principia College, Elsah, Ill.; Dr. Harry J. Fuller, Assistant Professor of Botany, University of Illinois, Urbana; Mr. Stanley A. Watson, graduate student in plant physiology, University of Illinois, Urbana.

While visitors are not required to register at the Garden, some idea of the wide range of states from which tourists come may be obtained from licenses on cars parked near the entrance.

On Sunday, September 1, and Monday, September 2 (Labor Day), a check was made during the afternoon and showed the following number of cars from twenty-three states. While many cars from Missouri, outside of St. Louis, were undoubtedly present, they were not included.

Illinois	100	Tennessee	6
Indiana	38	California	5
Kentucky	19	Texas	1
Kansas	18	Wisconsin	4
Iowa	11	Louisiana	3
Arkansas	9	Georgia	2
Alabama	8	Nebraska	2
Minnesota	8	New Jersey	2
Ohio	8	Oregon	2
Oklahoma	7	Colorado	1
New York	6	West Virginia	1
Michigan	6		

STATISTICAL INFORMATION FOR JUNE-SEPTEMBER, 1940

GARDEN ATTENDANCE:

Total number of visitors in June	31,472
Total number of visitors in July	29,629
Total number of visitors in August	33,338
Total number of visitors in September	32,632

PLANT ACCESSIONS:

Total number of plants and packets of seeds donated in June	276
Total number of plants and packets of seeds donated in July	50
Total number of plants donated in August	7
Total number of plants and seeds donated in September	11

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought in June	24
Total number of books and pamphlets donated in June	204
Total number of books bought in July	12
Total number of books and pamphlets donated in July	179
Total number of books and pamphlets bought in August	13
Total number of books and pamphlets donated in August	40
Total number of books and pamphlets bought in September	4
Total number of books and pamphlets donated in September	58

HERBARIUM ACCESSIONS:

JUNE

By Purchase—

Avenue Camera Store—Photographic prints of type specimens	50
Bracelin, Mrs. H. P.—Plants of Mexico, collected by Mrs. Ynes Mexia	124
Degener, Otto—Plants of Hawaii	88
Eyerdam, Walter J.—Plants of Alaska	175

By Gift—

Anderson, E.—Plants of Texas	11
Brown, William L.—Grasses	5
Erwin, A. E.—*Physalis* sp. from Mexico	1
Fraser, Rev. S. V.—*Allium* from Kansas	6
Hubricht, Leslie—Plants of Illinois, Missouri, Arkansas, Oklahoma, and Texas	291
James, Leslie—Plants of Alabama	2
McCart, William L.—Plants of Texas	25
Seibert, Russell J.—*Pithecoctenium* sp. from horticulture	1

By Exchange -

Field Museum of Natural History—*Calathea* sp. from Mexico	1
Smarods, J.—Fungi of Latvia	18
U. S. National Museum—Miscellaneous duplicates	403

By Transfer—

Fairburn, D. C.—*Stokesia cyanea* L'Herit. from horticulture	1
Total	1,202

JULY

By Purchase—

Eyerdam, Walter J.—Plants of Alaska	80
Skutch, Alexander F.—Plants of Costa Rica	254
Terry, Mrs. R. A.—Plants of Panama	297

By Gift—

Clark, Robert Brown—*Pistacia chinensis* Bge. from horticulture	3
Field Museum of Natural History—Photographic prints of type specimens	2
Greenman, J. M.—Photograph of type specimen of *Senecio huachucanus* Gray	1
Helton, Eugene—*Quercus* sp. from Missouri	1
Hubricht, Leslie—Plants of Illinois, Arkansas, Oklahoma, and Texas	99
James, R. L.—Plants of Alabama	2
Murrill, W. A.—Plants of Florida	1,100
Stillwell, Mrs. Norman—Plant from Texas	1

By Exchange—

Brooklyn Botanic Garden by H. K. Svenson—Plants of Tennessee	210
Field Museum of Natural History—Algae and bryophytes from various localities	42
University of California—Plants of California and Alaska	621
Total	2,713

AUGUST

By Gift—

Adam, H. A.—*Convolvulus japonicus* Thunb. from horticulture	1
Carney, J. E.—*Helianthus mollis* Lam. from Missouri	1
Degge, Jeanette H.—*Platycodon grandiflorum* A. DC. from horticulture	1
Featherly, H. I.—*Iva xanthifolia* Nutt. from Oklahoma	1
Greenman, J. M.—Photograph of type of *Tabebuia* sp.	1
Holtzen, E. E.—Plants of Missouri	3
Hubricht, Leslie—Plants of Missouri, Arkansas, and Texas	35
Kilian, E. H.—Photographs of *Arisaema*	3
Suits, Mrs. H. E.—*Eustoma* sp. from Texas	1
Von Schrenk, Hermann *Trifolium resupinatum* L. from St. Louis County, Missouri	2
Total	19

SEPTEMBER

By Purchase—

Lundell, C. L.—Plants of Mexico and Central America	350

By Gift—

Anderson, E.—Plants of Phelps County, Missouri	7
Anderson, E.—Plants of Missouri and Texas	9
Andrews, H. N. and G. T. Johnson—Fungi of southern United States	35

Clokey, Ira W.—Plants of Nevada 4
Cutler, Hugh C.—Plants of Texas 18
Degener, Otto—Corms of *Hillebrandia sandwichensis* Oliver, from Hawaii 1
Hubricht, Leslie—Plants of Missouri and Illinois 4
Instituto Miguel Lillo, by R. E. Woodson, Jr.—Asclepiadaceae of Argentina 357
Irish, H. C.—Plants of Iowa 88
Johnson, G. T.—*Coprinus cubensis* B. & C. 6
Leyendecker, P. J.—*Tradescantia Wrightii* Rose & Bush, from New Mexico 1
Von Schrenk, Hermann—Plants of New Hampshire 6

By Exchange—

Field Museum of Natural History—Photographs of type specimens of Panama plants 14
Field Museum of Natural History—Plants of tropical America 175
Gray Herbarium of Harvard University—Plants of Virginia 523
Iowa State College Plants of Iowa, etc. 788
Lundell, C. L.—Plants of Mexico and Central America 50
United States National Museum Plants of Virginia 173
University of California, by H. A. Mason—Fragments of type specimens 7

By Field Work—

Anderson, E., R. O. Erickson, and S. Bettoney—Plants of Pennsylvania and Ohio 8

By Transfer—

Cutak, Lad—*Bunchosia biocellata* Schlecht. from horticulture 1

Total 2,625

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NOTICE

ATTENTION is called to the recently issued "Spring Flora of Missouri" by J. A. Steyermark. About fourteen hundred plants blooming in Missouri and adjoining states are described and most of them illustrated. Designed primarily for nature-lovers, scouts, amateur botanists, etc., emphasis is placed on the common name; also, an attempt is made to write the descriptions in simple untechnical language so that, with the help of the keys and the illustrations, identification of spring-blooming flowers should not be difficult. The book is cloth-bound and comprises 590 pages, 163 plates, and 444 line drawings. For sale by the Missouri Botanical Garden. Price $3.00.

MISSOURI BOTANICAL GARDEN BULLETIN

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SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date to the death of Mr. Shaw, in 1889, the Garden was maintained under the personal direction of its founder, and while virtually a private garden it was, except at certain stated times, always open to the public. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was designated by Mr. Shaw as its official title and in his will and all of his writings he specifically referred to it as the "Missouri Botanical Garden." By a provision of Mr. Shaw's will the Garden passed at his death into the hands of a Board of Trustees. The original members of the Board were designated in the will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provison of the will, the immediate direction of the Garden is vested in a Director, appointed by the Board of Trustees. The Garden receives no income from city or state, but is supported entirely from funds left by the founder.

The city Garden comprises 75 acres, where about 12,000 species of plants are growing. There is now in process of development a tract of land of over 1,600 acres outside the city limits which is to be devoted to (1) the propagation and growing of plants, trees, and shrubs, designed for showing either indoors or outside, at the city Garden, thus avoiding the existing difficulties of growing plants in the city atmosphere; (2) gradually establishing an arboretum as well as holding a certain area as a wild-flower reservation, with the idea that possibly at some future time this may become the new botanical garden.

The Garden is open to the public every day in the year except New Year's Day and Christmas—week days from 8:00 a. m. until sunset; Sundays from 10:00 a. m. until sunset. The greenhouses are closed every day at 5:00 p. m.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Place, on the Sarah car line (No. 42). Transfer south from all intersecting lines.

1

2

3

HEDGES AT THE GARDEN

1. Screen planting of *Ulmus pumila*. 2. *Rhamnus Frangula*. 3. *Physocarpus intermedius parvifolius* and *P. monogynus*.

Missouri Botanical Garden Bulletin

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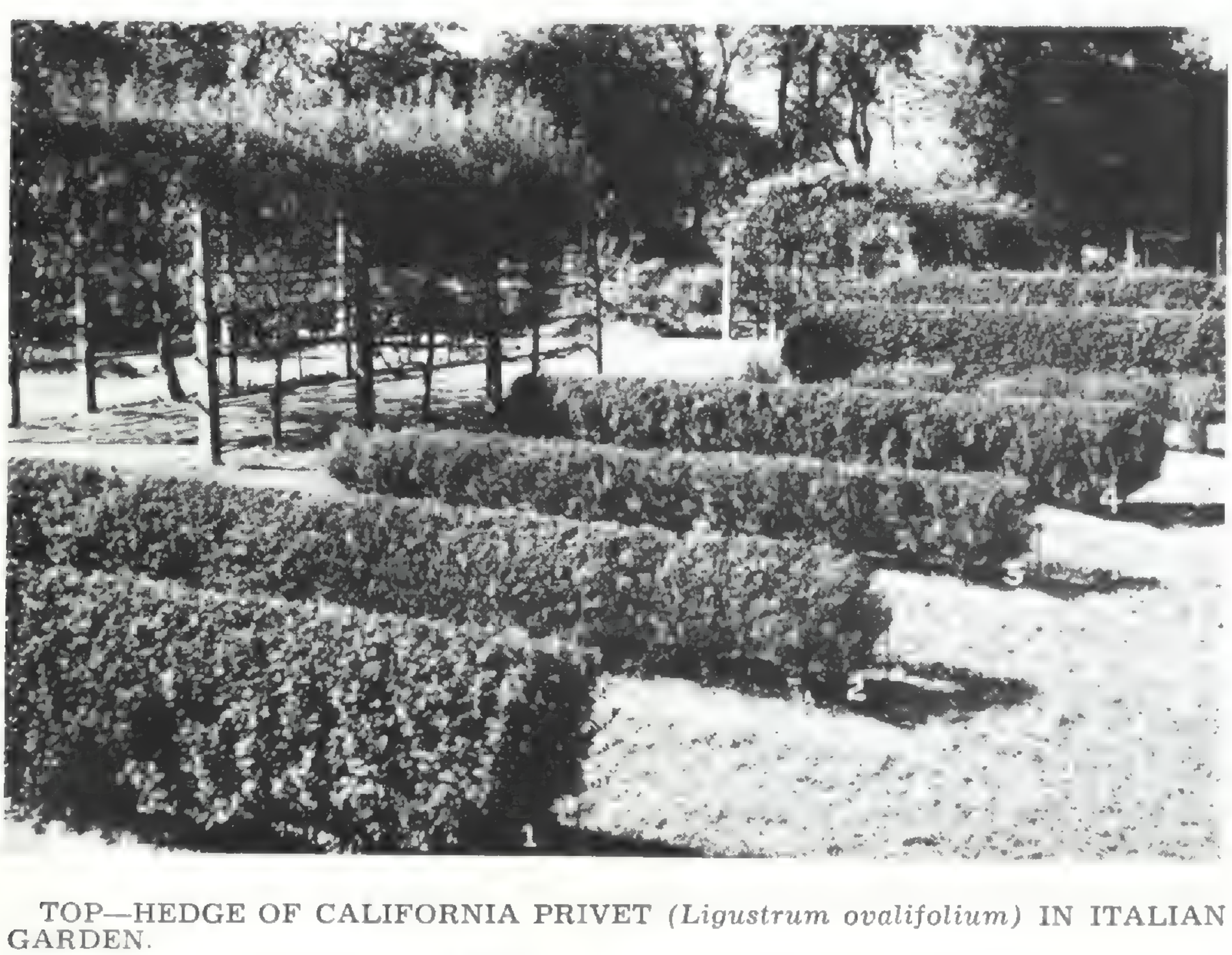
HEDGE PLANTS FOR ST. LOUIS

If one were to take a census to determine which hedge plants are used in the St. Louis metropolitan area the conclusion would soon be reached that there are only two, California privet and Japanese barberry. The reason is obvious. When a person decides to plant a hedge he is interested in the price and in plants that will grow with a minimum of attention. California privet has filled the bill for many years because it is the cheapest hedge plant, is easily handled, and will grow in almost every kind of soil and situation. It is semi-evergreen in this region and will retain its rich, dark green leaves as long as the temperature does not approach zero. What the average home-owner does not know is that this hedge freezes to the ground in severe winters, about every five to seven years. Barberry is the second choice because, in addition to its many good qualities, it may be used when there is need for a thorny hedge to stop trespassing.

There are many kinds of shrubs that may be closely planted to form a hedge, but some respond to clipping better than others. A hedge may be employed as a screen for privacy, as a barrier against intrusion, in boundary planting, as a background for flower borders, to form the architectural lines and divisions in the formal garden, or as an edging for flower-beds. In selecting a hedge for any of these purposes thought must be directed to the habit of growth, the texture and color of the foliage, and its adaptability to this climate. Some plants require more shearing than others if formal lines are to be preserved, and this is a consideration of major importance where a great deal of hedge is used.

A hedge grows best in the open where it receives a maximum amount of light. When planted under trees it suffers for lack of light and moisture, and this is very noticeable in dry years. Since a hedge remains in the same location for many years the soil should be put in good condition before any plants are set. Young plants, two to three years old, make the best hedges, and since they are planted rather close together it is better to make a trench instead of digging a separate hole for each plant. However, this is only necessary with larger plants that are spaced two or more feet apart or when the roots are surrounded with a ball of soil, as in evergreens. A formal hedge row must be straight, and this is best accomplished by stretching a line and placing stakes at regular intervals. The line is then removed, as it interferes with the planting. The ultimate height of the hedge will govern the placing of the plants. The taller the hedge, the broader the base will be after several years of training. A five-foot hedge will be about four feet wide, so the plants should be set at least two feet back from the boundary line. The distance between plants depends on the height of the hedge and the kind of plant. The plants in a dwarf border would be spaced six to ten inches apart, those in an eighteen-inch hedge a foot apart; stronger-growing plants for a taller hedge would be planted at least eighteen inches apart and sometimes two to four feet for large shrubs and trees.

Deciduous hedges may be planted in the fall after they have lost their leaves, or in the spring. If the plants are purchased from reliable nurseries and shielded from the wind and the sun before they are set there should be few, if any, losses. A thorough watering after the hedge is set will settle the soil around the roots and will prevent any damage from dryness at the time of planting. A newly planted hedge should be cut back hard to induce a bushy growth at the base. This refers particularly to plants with growth habits similar to the privets and barberries. Six inches is not too low for such plants; taller plants, or such as have a distinct leader, should be cut back to about a foot in height. As the hedge develops it should be carefully clipped until it finally assumes its true shape. Hedges up to three feet in height may be clipped square, but tall hedges should be narrow at the top and broad at the base in order that light may reach to the bottom. In the first few years the hedge can be shaped in early spring before the leaves develop.



TOP—HEDGE OF CALIFORNIA PRIVET *(Ligustrum ovalifolium)* IN ITALIAN GARDEN.

BOTTOM—BARBERRY HEDGES IN HEDGE DEMONSTRATION PLOT: 1. *Berberis mentorensis*, 2. *B. Thunbergii*, 3. *B. Thunbergii minor*, 4. *B. Thunbergii erecta*.

It must be sheared from three to four times during the summer to keep it in good condition.

A dwarf box hedge is the border plant we would like to have in our gardens. Attempts in the past to grow it *(Buxus sempervirens)* were discouraging because many young plants were frozen. Extensive experiments on different species and varieties of Buxus are now under way at the Arboretum and the results thus far seem to indicate that a perfectly hardy box may be obtained for St. Louis and vicinity. A subsequent bulletin will be devoted to this subject.

Teucrium Chamaedrys, the germander, has dark, glossy green leaves and when closely planted and sheared makes an excellent substitute for the box hedge. It retains its leaves well into the winter, or until the temperature drops to ten degrees above zero. In some years it is necessary to cut it to the ground in the spring but it soon assumes its normal shape.

It is possible to fashion a dwarf hedge out of *Euonymus radicans.* If closely planted and supported on each side by a low wire fence it makes a dense growth which soon hides the wire. It must be protected against winter injury and rabbits.

Acer Ginnala, the Amur maple, makes a good clipped hedge. The leaves turn red in October, and it is the most brilliantly colored hedge which can be grown under city conditions.

A barberry under the name of truehedge columnberry *(Berberis Thunbergii erecta)* is a very promising hedge. It grows very straight and needs little shearing. The past winter was an excellent test for its hardiness. In the fall the leaves turn red and remain on the plants longer than those of the Japanese barberry. Since its introduction in 1934 *Berberis mentorensis* has proved to be an excellent hedge plant. Unlike the other barberries it retains its dark green foliage well into the fall and early winter. Japanese barberry, *Berberis Thunbergii,* is the second most popular hedge. The colorful leaves in autumn and the red berries in winter make it particularly attractive, and its thorniness frequently helps to keep out trespassers. The box barberry, *Berberis Thunbergii minor,* has very small leaves and may be clipped quite low. It is not so colorful in the fall as the other barberries.

Carpinus Betulus, the European hornbeam, makes a dense hedge. It holds most of its brown leaves throughout the winter.

the new leaves appearing in April. This is a good but rather expensive hedge plant.

Cotoneasters are being recommended for hedges, and the Peking cotoneaster, *Cotoneaster acutifolia,* and *C. lucida* have been grown in the hedge plot at the Garden. Their leaves are glossy green. The plants make a dense growth and are perfectly hardy but, unfortunately, are subject to leaf rollers and scale insects.

Since hawthorns grow so well in this region they make excellent screen plantings. The cockspur thorn, *Crataegus Crus-galli,* is a good plant for this purpose. The smaller-leaved English thorn, *C. Oxyacantha,* forms a fine close-clipped hedge. Hawthorns are subject to scale insects and aphis and for that reason should be examined each year lest these pests become serious.

The Russian olive, *Elaeagnus angustifolia,* grows tall and makes an excellent background where a silvery gray color is desired. This cannot be considered a long-lived hedge.

Ligustrum ovalifolium, the California privet, is the hedge most commonly planted. Where other plants might be damaged by the intense heat when planted near the base of a building, this privet retains its rich green color. For twenty-five years California privet has been grown in the Italian Garden, during which time very few plants have had to be replaced. It makes a fine dense hedge when closely sheared but in time this constant clipping produces a stubby growth. If the hedge freezes to the ground once in five years it is really helped in that a new clipping surface is produced. Although it must be cut down after it is frozen, it soon recovers and by the end of June is at least fifteen inches high. For a low formal hedge this is a good plant to use. A strong-growing privet that closely resembles *L. ovalifolium* is the Ibolium privet. It stands shearing well, or it may be left to grow naturally to form a background or screen ten feet high. Only once, in the severe winter of 1933-34, was this hedge frozen to the ground. The Regel privet, *L. obtusifolium Regelianum,* is not affected by cold. It is distinct from the other privets in its horizontal branching and its longer but not glossy green leaves.

Two other privets in the hedge-demonstration plot have faults which should be mentioned. When the lodense privet was introduced in the early twenties it seemed a promising hedge for the Italian Garden and several thousand plants were propagated.

However, a twig blight developed in the nursery rows and for that reason this privet was never used. In recent years it has been grown at the Gray Summit Arboretum, with no evidence of twig blight so far. This same disease appeared in the European privet *(Ligustrum vulgare)*, and the plant has been discarded as undesirable. It was replaced with the Amur privet, *L. amurense,* which is reputed to be the hardiest of the privets. However, it has not been in the collection long enough to judge.

The white belle honeysuckle, *Lonicera bella albida,* makes a large hedge in a comparatively short time. It grows faster than any of the privets. The leaves are almost a blue-green and are just as fresh in the fall as in the spring. In early April this is the greenest hedge and very attractive. Probably its only drawback is that it needs frequent shearing if grown as a formal hedge. *Lonicera Xylosteum,* the European fly honeysuckle, has attractive foliage in spring but in summer it becomes very rusty.

Physocarpus intermedius parvifolius (the dwarf ninebark) and *P. monogynus* are two of the densest hedge shrubs. The leaves are small, barely three-fourths of an inch long, the general color effect being a yellow-green. The foliage does not color in the fall and drops soon after frost. These plants stand shearing well. Aphis attack the young shoots and must be sprayed with a contact spray in early summer.

Prunus tomentosa, the Nanking cherry, is one of the taller hedges. It blooms in spring even though it has been clipped. Unfortunately, the leaves become gray-green towards fall due to the numerous leaf hoppers.

Rhamnus Frangula, the glossy buckthorn, is an attractive hedge. It is the cold-climate counterpart of the beautiful cherry-laurel hedges, *Prunus Laurocerasus,* of milder climates. The foliage remains free from insects and diseases and retains its rich, dark, glossy green leaves until November. A hedge that also has laurel-like leaves is *Quercus imbricaria,* the shingle oak. This is a native tree which had to be collected as very few nurserymen grow it.

The syringas or lilacs are sometimes used in hedges and if left unclipped, as in the common lilac, are beautiful when in bloom. The Hungarian lilac, *Syringa Josikaea,* may be clipped into a formal hedge. Lilac foliage mildews in late summer. Unless a flowering hedge is wanted there is not much reason for using lilacs.

Ulmus pumila, the dwarf Asiatic elm, may be used as a tall hedge or as a screen. It grows rapidly and if sheared makes a dense growth. If used as a screen it will need at least two clippings a season to maintain its shape.

Viburnum Lantana, the wayfaring tree, forms a tall hedge that is always well clothed with leaves. It is hardy and is not bothered by insects, and if the foliage were more attractive it would be considered one of the best hedges.

Other hedges have been given a trial but have been discarded because of some fault. It was hoped that the shiny-leaf honeysuckle *(Lonicera nitida)* could be used as a hedge, since it is such a compact and attractive little plant. However, with or without protection it looked poor in the spring and during the winter many of the branches were completely frozen. It is being given a second trial in which it will be treated as a tender perennial and protected in a cold-frame during the winter.

Salix pentandra, the laurel willow, was also tried with the hope that it would be a good substitute for the tender cherry-laurel hedge. As a hedge plant it was a failure for it suffered from dry weather, numerous poplar beetles disfigured the foliage, and some of the plants died from a crown gall at the base of each plant.

Ribes alpinum, the mountain currant, had to be removed from the hedge garden because the leaves were badly sunburned. The plants are now growing in the shade and are doing much better.

Other plants on trial, but from which comments are withheld until more data are available are: *Acer campestre, Bumelia lanuginosa, Cotoneaster horizontalis perpusilla, Euonymus alata compacta, Euonymus patens, Taxus cuspidata capitata* and *Thuya occidentalis.*

All but three of the plants described in this article are growing in the hedge-demonstration plot in the Economic Garden, which contains thirty-five kinds of hedges. P. A. K.

DON'T BURN THE LEAVES

A fire in the woods at night is spectacular but it does so much harm that every forester and every agency concerned in the growing of trees devotes an appreciable portion of its annual budget of both time and money to the prevention and control of forest fires.

The very common custom of setting the woods on fire has a parallel in our city gardens. The fires are less spectacular, however, since metropolitan fire departments rarely permit even a grass fire to make much headway. Just the same, almost every city garden will be "burned over" when the leaves are raked and burned. The damage will be exactly as great as with a woodland fire but we won't find charred fence-posts and blackened buildings about the city. The forest fire is so serious because it reduces the growth rate of trees, kills off seedlings needed to restock the region, permits noxious weeds to grow on the bare soil, reduces the quality and sometimes totally destroys the value of the woodlot as marketable timber. It accelerates erosion, since the leaf-mold is destroyed, and exposes soil to much more rapid drying. Most city gardens will be no better off than the blackened woodland after the fall clean-up. It is the rotting leaf-mold of the woodland that checks drying, controls erosion, furnishes food and proper conditions for seedling growth, and these are exactly the requirements for good growth of trees and shrubs in the city.

Expert gardeners often feel of the soil and say that it seems "dead." While it would be difficult to explain exactly how a "dead" soil feels and looks, the description is accurate. The loss of humus through the raking and burning of leaves finally reduces the organic matter to the point where it will no longer support the myriads of bacteria so essential to plant nutrition, and a soil without humus is actually dead.

We can overcome and avoid these troubles if we simply DON'T BURN THE LEAVES. The very best trees and shrubs are often found in out-of-the-way places, far from the kind attention of a gardener. Certainly no leaves are raked from around such plants, and this is the very reason why they flourish. Let's do more lazy gardening. Let's sweep the leaves off the lawn and into the shrubbery bed or around the trees and leave them to rot. If there are more than enough for this purpose, then compost them.

It is not difficult to compost leaves and produce leaf mold satisfactory for gardening purposes. Simply place them in a pile when they are damp, or add water if they are very dry. They may be placed in a wooden bin, in a bin having concrete sides and bottom, or just enclosed in wire netting strung on fence posts. To hasten decomposition they must be compacted, and this is most

SHREDDER OPERATING NEAR COMPOST STOCK PILES

COVERED BINS FILLED WITH SHREDDED LEAVES AND SHREDDED COMPOST

easily done by turning a garden hose on them after all have been gathered. Even a well-compacted compost pile will shrink one-half or one-third in height during the first few months, so make the pile so high that it will not dry out during the summer. Any kind of leaves can be turned into leaf-mold, although oak leaves decompose more slowly unless other leaves are mixed with them. To accelerate the process a commercial fertilizer might be added, and the final product might be made as valuable as rotted stable manure.

Since oak leaves are more difficult to compost they were made the subject of a special study; eight lots were gathered in Florissant and brought to the Garden, where they were treated differently to determine the best way to hasten decay. Each lot contained nine and one-half bushels of dry red-oak leaves and was placed in a chicken-wire bin measuring three feet by three feet. They were treated in the following manner:

(1) 9½ bu. leaves covered with 6 bu. oak sawdust.

(2) 9½ bu. leaves mixed with 5 bu. sawdust when placed in the bin.

(3) 9½ bu. leaves used as a check—no treatment.

(4) 9½ bu. leaves mixed with 4 bu. of soil.

(5) 9½ bu. leaves mixed with 2½ bu. peat.

(6) 9½ bu. leaves mixed with 8 bu. manure in alternate layers.

(7) 9½ bu. leaves mixed with 20 lbs. of commercial 10-8-6 fertilizer.

(8) 9½ bu. leaves passed through a shredder.

While there was some difference in the speed of decomposition due to the different treatment, actually any one could have been used as leaf-mold in the making of a new garden, after one year's time. Oak leaves therefore can be converted into leaf-mold, and if other leaves are added, as would be the case in most gardens, a usable material will be produced if the pile is turned once during the year.

Leaf-mold which is one year old is sufficiently decomposed and may be used anywhere, except as a top-dressing for lawns. Usually in the process of raking, piling, compacting and turning, many weed seeds are gathered and some germinate so that there

is a valid objection to the use of such material on turf. For the past several years, all the leaves within the Garden have been swept into the nearest shrubbery beds, and while this at times may appear somewhat unsightly or may be criticized as lazy gardening, the thick layer of leaves will do for the shrubbery exactly what leaf-mold does for the woodland. It has been interesting to observe the germination, in these beds, of acorns and walnuts planted by the squirrels. Without the leaf mulch conditions would not be suitable for the growth of seedlings, and dry weather would do much more harm to the plants.

In addition to the leaves swept into the shrubbery beds, others are formed into great piles for compost; many loads come from the city streets. These are usually very wet, and have often undergone some mechanical injury by passing traffic, but they become very acceptable leaf-mold when passed through the shredder. A shredder is some form of power-driven machine having a spinning rotor, and fitted with knives which break up the leaves. The model built and in use at the Garden is also capable of separating gravel, cinders, tin-cans and bricks from the leaves, and turning out a very satisfactory product from very rough material. Most gardens are too small for the use of a mechanical shredder. Its chief advantage is that it speeds up the process of decomposition and makes it possible to use any leaves within the period of a year.

Ordinarily, surplus leaves are formed into piles 150 feet long and are left just as they are placed with a dump truck. If time permits, these piles are turned by hand once during the year; if there is no opportunity to do this, they are hauled directly to the shredder and after passing through the machine are deposited in a covered bin holding about forty cubic yards. They remain under cover until used, which may be but three weeks or perhaps three months. The bin is again filled from the stock pile, which, despite its size, rarely lasts longer than a year.

Since it is customary to rake leaves each fall it would require little more effort to compost them than it takes now to burn them, and the advantages to the garden will far outweigh the extra labor involved. The formula then, for growing vigorous, drought-resistant trees and shrubs is simply DON'T BURN THE LEAVES.

A. P. B.

WINTER COURSE IN GARDENING FOR AMATEURS

The elementary course in various phases of gardening for amateurs, which has been conducted at the Garden for the past few years, will be omitted in 1941. However, a course in gardening for amateurs, calculated to give the students as much practical work as possible, will start in February, 1941. The classes will be held in the experimental greenhouses, Wednesdays and Fridays, 10:00 to 12:00 a. m. Due to the large enrollment it will be necessary to divide the class into two sections, one group meeting on Wednesday and the other on Friday. Students may elect either one of the two days. The course will be in a charge of Dr. Fairburn.

REGISTRATION: It is desirable that registration be made by letter, with check enclosed payable to the Missouri Botanical Garden, as soon after January 1 as possible. Tickets will be ready for distribution on day of first lecture.

FEE: The registration fee is $10.00 per student, and tickets are not transferable.

February 5 and 7—The selection and care of house plants. How to force bulbs.

February 12 and 14—The preparation of fertile garden soil. Soil testing.

February 19 and 21—How to improve soils by the use of fertilizers.

February 26 and 28—Identification and control of comman garden insects and diseases.

March 5 and 7–April 2 and 4—Plant propagation. Five class periods will be devoted to this subject in order that the students may become familiar with a variety of plants and how to raise them from seeds and cuttings.

April 9 and 11—Potting of plants raised from seeds.

April 16 and 18 –Potting of plants raised from cuttings.

April 23 and 25—Landscaping the home grounds. Lawns.

April 30 and May 2—Garden work demonstrated:
Pruning trees and shrubs.
Application of lime and fertilizers.
Cultivating.
Digging and preparing flower beds.
Planting annuals and perennials.
Transplanting trees, shrubs and herbaceous perennials.

May 7 and 9—Trip to the Garden Arboretum at Gray Summit where the students will have opportunity to see the large collection of orchids, the pinetum and many native plants.

NOTES

Dr. David C. Fairburn, Horticulturist to the Garden, has an article, "The Winter Storage of Tender Bulbous Plants," in the November number of *Real Gardening* (**3:** 37-42).

Mr. Ladislaus Cutak, in charge of Succulents at the Garden, gave an illustrated talk, "Hunting Cacti in Mexico," before the Cooperative Club, at the Hotel Statler, November 13.

Dr. Edgar Anderson, Geneticist to the Garden, and Mr. Leslie Hubricht are the authors of a paper in the November number of *Bulletin of the Torrey Botanical Club* (**67:** 639-648), entitled "A Method for Describing and Comparing Blooming-Seasons."

Mr. L. P. Jensen, Manager of the Garden Arboretum, has been re-elected president of the Gray Summit Garden Club, and he has been appointed a member of the standing committee on arboriculture of the American Institute of Park Executives.

Mr. George H. Pring, Superintendent of the Garden, has been appointed a special member of the committee to judge the silver-leaf maples given last spring by Mr. John S. Swift to the school children of St. Louis. Prizes are to be awarded to those having the best-grown trees.

Mr. L. P. Jensen, Manager of the Garden Arboretum, gave a talk before the St. Louis Naturalists' Club, October 12, on "Old Herbals" and "Naturalists I Have Known"; before the Wright Garden Club of St. Louis County, October 16, on "The Missouri Botanical Garden Arboretum"; and before the Missouri Valley chapter of the American Society of Landscape Architects, October 19, on "The Missouri Botanical Garden Arboretum" and "The Henry Shaw Gardenway."

The following out-of-town members of the Missouri Valley chapter of the American Society of Landscape Architects visited the Garden Arboretum on October 19: Mr. S. Herbert Hare, Mr. Donald W. Busch, Mr. C. V. Cooper, and Mr. H. G. Whiffen, of Hare & Hare, Landscape Architects, Kansas City, Mo., Mr. Herbert Brackney, of the State Park Board, Jefferson City, and Mr. E. H. Dormann, of the Alton Park Department, Alton, Ill.

Recent visitors to the Garden include: Dr. Albert J. Mangelsdorf, Chief Geneticist, Hawaiian Sugar Planters' Association, Honolulu; Mr. Robert Pyle, of the Conard Pyle Co., Rose Growers, West Grove, Pa.; Dr. Louis M. Massey, president of the American Rose Society; Mr. Thurman Wilkins, of the Huntington Gardens, San Marino, Calif.; Mr. William F. Wight, of the Division Horticultural Crops and Diseases, U. S. Department of Agriculture, Palo Alto, Calif.; Dr. John B. Routien, Instructor in Botany, and Mr. Howard Harris, graduate student, both of the University of Missouri, Columbia.

Mr. George H. Pring, Superintendent of the Garden, has given the following talks recently: October 15, "The Missouri Botanical Garden," before the Coterie Club, at the Hotel Kingsway; October 24, "Conservation," before the Marguerite Krueger Conservation Club; November 7, "Jungle Experiences in the Andes of South America," before the Parent-Teachers' Association of the Twillman School; November 13, "Floral Displays Throughout the Year," before the Granite City Community High School; November 16, "Collecting Orchids in the Andes of South America," before the Pi Beta Phi Fraternity of the University of Illinois, Urbana.

STATISTICAL INFORMATION FOR OCTOBER, 1940

GARDEN ATTENDANCE:

Total number of visitors	36,297

PLANT ACCESSIONS:

Total number of plants and seed packets received as gifts	142

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought	11
Total number of books and pamphlets donated	219

HERBARIUM ACCESSIONS:

By Purchase—

Gentry, Howard Scott Plants of Mexico	930
Moldenke, Harold N.—Plants of eastern United States	565

By Gift—

Anderson, Edgar—Photographic enlargements of buds of *Fraxinus*	29
Bartlet, H. J.—*Psychotria dispersa* Standl. from Panama	1
Bennett, F. L.—*Glyceria grandis* S. Wats. from South Dakota	2

Brenner, Louis G., Jr.—Plants of Mississippi and Tennessee	7
Clemens, Mrs. Joseph—*Hymenophyllum* sp. from Borneo	2
Ehlers, J. H.—Plants of Colorado	11
Erickson, R. O.—Plants of Illinois	2
Erwin, A. T.—Plants of horticulture	2
Featherly, H. I.—Plant of Oklahoma	1
Greenman, J. M. and E. C. Berry *Wolffiella* sp. from Illinois	1
Heising, Clara—Plants of New Mexico	2
Hubricht, Leslie—*Wolffiella floridana* (J. D. Sm.) Thomp. from Illinois	1
Kammerer, Alfred L.—*Baptisia tinctoria* (L.) R. Br. from Pennsylvania	1
Kearney, T. H. and R. H. Peebles—Plants of Arizona	4
Murrill, W. A.—Plants of Florida	17
Parks, H. B.—Plants of Texas	12
Porsild, Morten P.—Plants of Greenland	32
Sperry, Omer E.—Plants of Texas	5
Turner, J. Arthur—*Verbesina encelioides* (Cav.) B. & H.	6
By Exchange—	
Rancho Santa Ana Botanic Garden—Plants of California	29
Schallert, P. O.—Plants of North Carolina	407
United States National Museum, Washington, D. C.—Plants of Peru	10
By Field Work—	
Woodson, R. E., Jr.—Plants of Panama	8
Total	2,087

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NOTICE

ATTENTION is called to the recently issued "Spring Flora of Missouri" by J. A. Steyermark. About fourteen hundred plants blooming in Missouri and adjoining states are described and most of them illustrated. Designed primarily for nature-lovers, scouts, amateur botanists, etc., emphasis is placed on the common name; also, an attempt is made to write the descriptions in simple untechnical language so that, with the help of the keys and the illustrations, identification of spring-blooming flowers should not be difficult. The book is cloth-bound and comprises 590 pages, 163 plates, and 444 line drawings. For sale by the Missouri Botanical Garden. Price $3.00.

MISSOURI BOTANICAL GARDEN BULLETIN

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SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date to the death of Mr. Shaw, in 1889, the Garden was maintained under the personal direction of its founder, and while virtually a private garden it was, except at certain stated times, always open to the public. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was designated by Mr. Shaw as its official title and in his will and all of his writings he specifically referred to it as the "Missouri Botanical Garden." By a provision of Mr. Shaw's will the Garden passed at his death into the hands of a Board of Trustees. The original members of the Board were designated in the will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provison of the will, the immediate direction of the Garden is vested in a Director, appointed by the Board of Trustees. The Garden receives no income from city or state, but is supported entirely from funds left by the founder.

The city Garden comprises 75 acres, where about 12,000 species of plants are growing. There is now in process of development a tract of land of over 1,600 acres outside the city limits which is to be devoted to (1) the propagation and growing of plants, trees, and shrubs, designed for showing either indoors or outside, at the city Garden, thus avoiding the existing difficulties of growing plants in the city atmosphere; (2) gradually establishing an arboretum as well as holding a certain area as a wild-flower reservation, with the idea that possibly at some future time this may become the new botanical garden.

The Garden is open to the public every day in the year except New Year's Day and Christmas—week days from 8:00 a. m. until sunset; Sundays from 10:00 a. m. until sunset. The greenhouses are closed every day at 5:00 p. m.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Place, on the Sarah car line (No. 42). Transfer south from all intersecting lines.

PAGODA PLANT
(Bryophyllum daigremontianum)

Missouri Botanical Garden Bulletin

Vol. XXVIII DECEMBER, 1940 No. 10

THE INTRIGUING BRYOPHYLLUM

During a conversation with Mr. Charles F. Swingle, of the United States Department of Agriculture, when he was at the Garden several years ago, he related some of his experiences in the Madagascan hinterland. With Professor Humbert, of the Paris Museum, he had been sent to that large island in search of *Euphorbia Intisy,* a plant yielding an exceptionally high quality of rubber. "Although the botanist will find much of interest in any part of Madagascar," he said, "it is the desert region that holds a strange fascination. Much of the southern part from Tulear on the Mozambique Channel to Fort Dauphin on the Indian Ocean is a flat country, and because of the scarcity of rain, only plants that are able to utilize moisture from the air or to store enough water within themselves are able to live successfully." Then he described the xerophytic plant life as being so abundant in many places that it was impossible to penetrate the dense thickets. "The beauty of the ornamental plants was in striking contrast to the severity of their surroundings," he continued, "and the succulent multicolored leaves of kalanchoids—and of others—all did their best to soften the harshness of the desert plains."

On the mention of kalanchoids I was doubly interested since this group of the Crassulaceae contains some of the most outstanding members of the family. In its floral construction the group is characterized by a four-parted, more or less tubular flower with the petals united except at the tips. The genera Kalanchoe, Bryophyllum and Kitchingia constitute this assem-

blage of succulent herbs and sub-shrubs, but sometimes they are all found under the one name Kalanchoe.

The genus Bryophyllum does not represent a large number of species but many of them are established as universal favorites. They grow with the greatest of ease and may even become a nuisance because many of them reproduce viviparously; by that is meant that tiny baby plants sprout all along the serrated margins of the leaves, even while these are still attached to the mother plant. An enterprising dealer has hit upon the idea of selling the leaves of *Bryophyllum pinnatum* as a good-luck charm. Single leaves are wrapped in cellophane and marketed at ten cents apiece. This isn't the first time that this peculiar Bryophyllum has had a superstitious significance. Among the West Indians of the Panama Canal Zone a favorite method of testing the fidelity of a sweetheart is to place a leaf of this plant above the lover's door. If a new plant is produced at each notch, her faithfulness can not be questioned. As a remedy for headache the savages used to rub the leaves over their heads and the juice was used in earache and as a lather for shaving.

The Bryophyllums, for the most part, are natives of Madagascar, but one of them, *Bryophyllum pinnatum,* has become cosmopolitan, being found in all the more or less tropical portions of the earth. In Bermuda it grows on walls, in thickets, woodlands and waste grounds. In Ceylon it is a common plant on bare rocky places throughout the lower mountain country, and has all the earmarks of a native. In the West Indian Islands and in Central America it is often planted for ornament or as a curiosity, and in many localities has become thoroughly naturalized. In Florida it finds its place in foundation plantings on the rich estates. In Mexico I came across this plant in the most unbelievable location. While scouting around in the vicinity of Cordoba, the very heart of the coffee-producing region in the State of Vera Cruz, I fought my way through a thick growth of the jungle and beside an inky pool, shaded by the lacy fronds of the fern *Cibotium Schiedei,* I espied a dense colony of *Bryophyllum pinnatum.* And this plant, xerophytic in habit, evidently was drenched with moisture, yet it grew luxuriously.

The Bryophyllums require only simple care, such as would be

given to an Aspidistra or Sansevieria, and many species make excellent house plants. There is enough diversity among the score of species to please everyone. Most of them are robust growers, even in the window, and the leaves of some varieties become highly colored. Propagation can be accomplished from leaves or from cuttings and offshoots. It is necessary only to place a leaf upon moist soil and several new plants will appear within a short time. Life is so strong in these plants that new growth will appear even when attempting to dry a specimen for herbarium use.

The best-known Bryophyllums are numbered among the following: *B. pinnatum,* as stated previously, is a universal favorite. You will find it listed often as *B. calycinum* in the various Floras. It has very fleshy leaves, bright green in color, and large panicles of flowers, lantern-like in appearance. It is commonly called "chandelier plant." *B. daigremontianum* possesses large, broadly ovate to acutely triangular succulent leaves, which are in two colors and marked with scattered splotches on the under-sides. The flowers are rose-purple and bloom profusely. The plant is referred to as the "pagoda plant" on account of its striking resemblance in shape to a Buddhist temple. *B. tubiflorum* is immensely interesting, because the slender, straight stems are beset with mottled tubular leaves. Thick bunches of pinkish, tube-shaped flowers grace the slender stalks. An interesting hybrid between *B. daigremontianum* and *B. tubiflorum* was produced by the late Dr. A. D. Houghton, which is already creating quite a stir among Bryophyllum enthusiasts. *B. Fedtschenkoi* is another beauty, a compact grower with grey-blue leaves turning a rich lilac when deprived of water and grown in full sun. All the above are free-flowering types and worthy of inclusion in a choice selection of house plants. L. C.

LIGHTNING AND TREES

Lightning, the most spectacular, if not the most powerful manifestation of Nature, intrigued man for centuries before Benjamin Franklin began experimenting with thunderstorms. Poets and writers have often made use of the phenomenon; the witches in Hamlet are ushered onto the stage on a clap of thunder.

Although much of the supernaturalness has disappeared, we are still impressed when we have an opportunity to examine a tree struck by lightning and see the effect of the tremendous energy that is so suddenly released.

The literature dealing with the effects of lightning on trees is somewhat overwhelming. In 1664 Sir John Evelyn suggested the pruning of lightning-injured trees in March, and as a prophylactic, "the burning of straw and aromatic leaves in suspicious weather to prevent entrance of insects and diseases." The "Philosophical Transactions of the Royal Society of London," in 1732, contains two items of interest. The first, "The Effects of Thunder on Trees," by Sir John Clark, describes the injury to two huge oaks, one of which had a "piece cut out of the tree" 3 inches wide and 2 inches deep from top to bottom, and another in which the same kind of injury produced a "spiral band," making three turns about the tree before entering the ground. The second article, "Concerning Some Extraordinary Effects of Lightning," by Rt. Hon. Robert James, describes two large oaks 40 to 50 feet apart. One of them was shattered and split, and the bolt entering the ground made a hole 6 or 7 inches in diameter and over a foot deep. The other oak was not shattered, had no broken branches, and the path of the lightning could be traced only by the strip of bark which had been torn away. This strip was 5 inches wide and began 40 feet from the ground, encircling the trunk just once. The surface of the bark on both trees, however, appeared to have been peppered with bird shot.

Prof. Pleinger, in 1851, describes an "explosive action" (apparently the first use of this term), in which a bolt striking an oak, 80 to 90 feet high, ripped away all the bark and reduced the bole of the tree to matchwood. He noted that the trunk appeared to have spread open during the instant of the stroke since small slivers fell inside and became wedged there; while a fragment, 6 feet long and weighing 25 pounds, was thrown over a neighboring beech and landed 250 feet away. Pleinger appears to have been among the first to use the term "fluid electricity" and expressly distinguishes between "heat strokes," which might set a tree on fire, and the "explosive stroke," just described. This last type he ascribes to a sudden mixing of warm and cold air. Four

A stroke which immediately killed the top of a red oak and left a few live branches lower down.

"Explosive" stroke. Total destruction of a white oak.

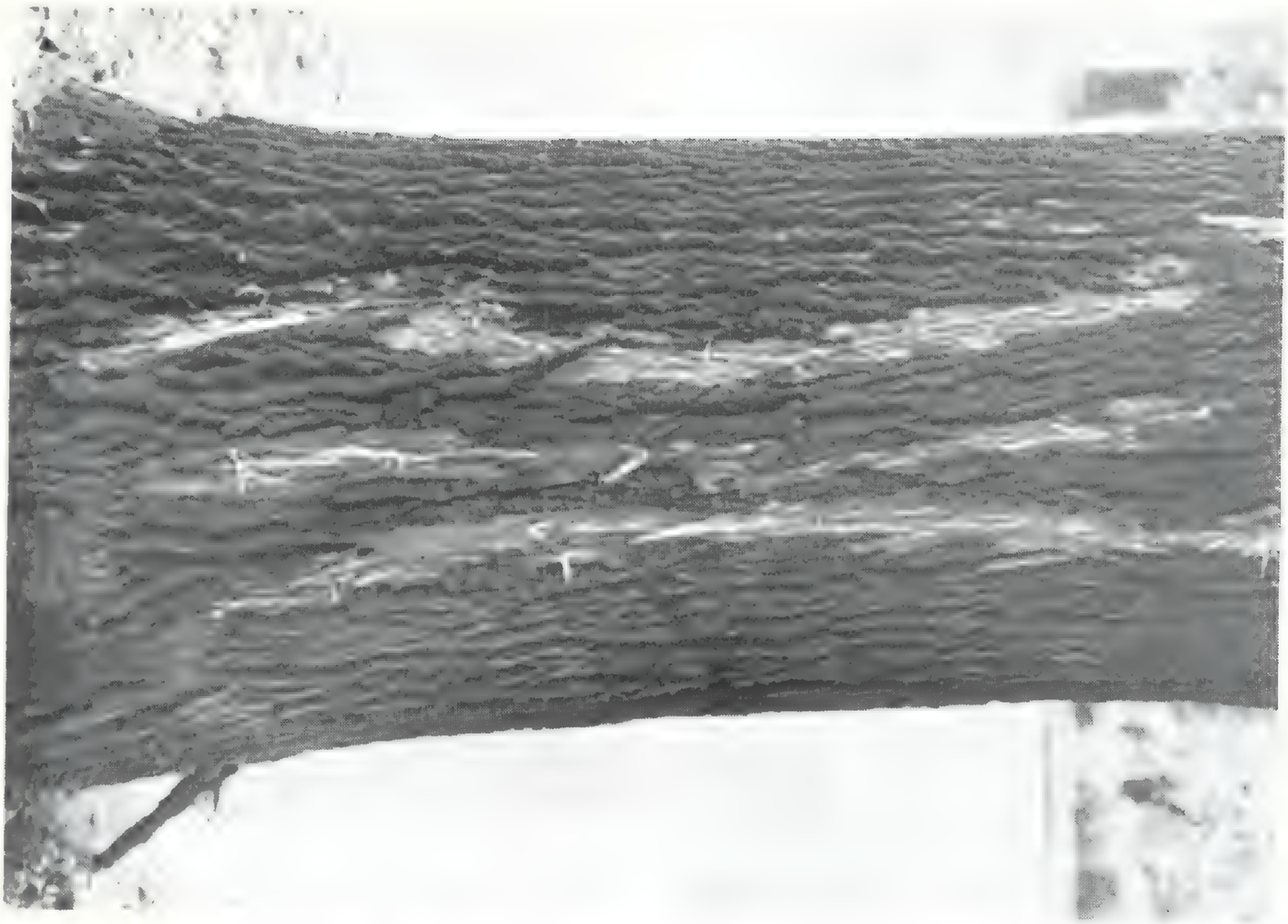
EFFECT OF LIGHTNING

years later he wrote of a "mysterious lightning" in which two oaks were struck at the same time. The first one was hit at a height of 40 feet, the damage shown by the loss of a one-inch strip of bark; while the second tree, 12 feet away, was struck on an outward side 20 feet from the ground, a zig-zag injury resulting which was intermittent on the trunk and appeared to follow a branch and jump to the adjoining tree.

The possible role of soil moisture in "drawing lightning" is shown in a paper by Prof. Colladon. He described a poplar at Geneva, Switzerland, which was struck with no visible injury except the removal of portions of bark from the trunk. This tree was examined in the expectation that water would be discovered at the roots, and a water pipe and waste-water drain were found just four yards away. This paper also draws attention to the fact that birds are seldom killed by lightning, since they are in the tree tops, while people beneath the tree are frequently killed. However, there are instances on record, in which thousands of fish perished when a bolt struck the sea.

Lovering, in 1855, quoted Brydone as suggesting the advisability of connecting women's bustles and the bird-cage hats of the period with a wire trailing on the ground as a precaution against lightning strokes—after the manner of a modern gasoline truck dragging a chain to ground static electricity. The proposal to carry your personal lightning rod seems never to have become popular, although at one time serious objections to the common use of metallic money entered any discussion dealing with lightning—it was felt that the possession of such money exposed the owner to unnecessary risks during a storm!

In 1883 Dod reported an ash tree set on fire. While there were twenty oaks to one ash in the grove, within the preceding twelve years three of the five trees struck had been ash. A year later the "Gardeners' Chronicle" published an illustration of an ash wholly destroyed by lightning. This tree was described as 8 feet in circumference. Illustrations of lightning injury to trees become more frequent in publications after this date. Webster, in 1890, reported a turkey oak destroyed by lightning, the illustration showing the trunk reduced to shingles and some of the wood actually seared. The bolt when entering the ground made a hole



A "forked" stroke on trunk of a tulip tree.

EFFECT OF LIGHTNING

A deep gash in trunk of a white oak

21 inches deep and parts of bark were found 100 yards away, while one piece of timber, weighing 243 pounds, was thrown nearly 50 feet. An anonymous contributor to "Gardeners' Chronicle" (June, 1894) describes a 70-foot oak from which the crown had been torn off without other injury, but with the lower portion of the trunk shattered and splintered in such a manner that pieces could be found over a 50-acre meadow. A contributor to "Nature" (February, 1896) gathered together most of the European work up to that time and quoted statistics to the effect that between 1879 and 1890 lightning struck 56 oaks, 3 or 4 pines, 20 or 21 firs, but not a single beech; yet the forest was made up of 70 per cent beech, 11 per cent oaks, 13 per cent pines, and 6 per cent of firs. At that time Fisher and Surog were investigating the chemical composition of the wood of trees to determine why lightning appeared to select certain species. They showed that those trees rich in oil and resin during the summer were not struck, while those containing much starch were more liable to be singled out. Schubler and Hartig were interested in the relationship between the moisture of wood and the passage of electricity. Jonescu attempted some controlled experiments on the electrical resistance of wood and constructed a spark coil having a capacity of 30,000 volts to determine the difference in the conductivity of wet and dry wood. He also extracted the oils and resins with ether to learn if this had an effect on the resistance. His conclusions were substantially the same as Fisher and Surog, who contended that trees containing starch are most often struck while oily species are not.

From the above much-abbreviated review it will be seen that men have had much difficulty in explaining lightning, and not much success in devising protection against it until Franklin introduced the lightning rod. The terminology of lightning has also undergone considerable change. Early authors seemed to ascribe most of the injury to the thunder following the flash; later the flash itself was considered as the agent of destruction, and still later such terms as "fluid electricity" appear in the literature. After the heated controversy following Franklin's experiments with lightning rods had subsided fewer "mysterious" cases of lightning strokes were reported. However, we find that two very

new scientific terms—cosmic rays and hydrogen ions—are being woven into modern lightning terminology.

The most comprehensive American survey of lightning damage to trees was undertaken by A. Robert Thompson, in 1936, in connection with the National Shade Tree Conference. He has gathered together, with the assistance of many cooperators, 140 case records from all over the United States. While, as has been shown, many theories have undergone change or have been discarded, it is interesting to note that the preference of lightning for oaks is clearly shown in this survey. No beech has been a victim while oak, elm, and pine, in the order named, make up the bulk of the case reports. In regard to the position of struck trees, about one-half have been members of a group. The report also shows that the tallest trees are not always singled out, since over half of the trees were no taller than their neighbors. We might expect very small ones to be less frequently struck, and this is shown by the survey. Most of the trees reported on have been from 60 to 80 feet in height. That no one can determine beforehand what effect the position or location of a tree has on its attractiveness to lightning is shown by a table indicating that most of the trees struck were growing on level ground.

During the years 1932 to 1934 three very large sycamores in the Garden were struck repeatedly—the largest at least three times in two summers. The damage was rather slight and at one place the lightning "jumped" across a copper label, doing no damage to the bark beneath it but fusing two corners of the label. In July, 1934, an experimental installation of lightning rods was made in all three trees. To test their efficiency, gaps a foot long in the main conductors separated the system near the top from that near the trunk and base. In the middle of each of these gaps copper or glass plates were placed at right angles to the opening, on the assumption that a direct bolt would either fuse the copper plate or fracture the glass. In the seven years since these lightning rods have been installed the trees have not been struck. This, of course, is negative evidence; but it is generally accepted that lightning rods function in just that manner. Presumably they dissipate a potential which is slowly building up during a storm and thus at no time is the area about the tree surcharged with

electricity. Based on our experience, and that of many others in various parts of the country, it appears that lightning rods offer ample protection for valuable trees.

The accompanying photographs show injury to some species of trees and also show a few of the major types of injury—the "explosive" stroke, the ruptured bark, and the sliver of wood and bark removed. The path of the stroke can usually be followed for a considerable distance up the tree -sometimes within a few feet of the top. In sycamore, however, a stroke does no damage above the point where the heavy corky bark (characteristic of old trunks) ends. This brings up the interesting immunity of beech to lightning; perhaps beeches are struck but never show injury just as the very smooth upper branches of sycamore are not injured. Of all the American trees only beech and sycamore retain the extremely smooth, cork-free bark for any length of time. While the largest and oldest sycamores finally develop a very heavy bark, the beech remains very smooth throughout its life. Perhaps the beech is not immune to lightning. Perhaps the answer will be found in its very smooth, easily wetted bark which may be a very efficient conductor of electricity when compared with the thick, corky and water-resistant bark of such trees as the oaks.

Almost every species of tree which attains considerable size has been struck by lightning, and following a thunderstorm in July, 1939, we are able to add the ginkgo to the list. This we believe to be the first record of ginkgo being struck by lightning in this country.

A. P. B.

A HARDY WOODY PLANT NEW TO HORTICULTURE

On the glades and bald knobs of the Ozarks there is frequently found a shrub or small tree which for resistance to extreme conditions of drought and heat is unsurpassed even by the familiar red cedar. This is the "chittim wood" or "woolly buckthorn," *Bumelia lanuginosa*. To be sure, it never becomes a very conspicuous element in the landscape and, perhaps for this reason more than any other, has been neglected by gardeners; but throughout the changing seasons few other plants can equal its

dependable performance. Furthermore, from early May to late November its light green leaves are in evidence, it being one of the last deciduous plants to lose its foliage.

Owing to its naturalistic character, chittim wood may be recommended for planting where an informal effect is desired, as, for instance, in a sunny courtyard. Since it also seems to respond favorably to shearing, it may make a suitable subject for a formal hedge or a structural plant.

Description.—To those unacquainted with Bumelia a brief account of its outstanding characters is appropriate. It is a shrub or small tree with numerous rigid, rather slender and thorny branches, slightly milky sap, and yellowish and exceedingly tough wood. The young twigs and the lower surface of the leaves are generally covered with dull tawny hairs. The leaves are obovate or spatulate, having smooth margins and short petioles, and arise either alternately on long shoots or fascicled on the short ones. The species does not flower and fruit every year at the Arboretum. When it does, the flowers, usually borne in clusters, are whitish or creamy in color and blossom in mid-July. The fruit is a purplish-black berry with fleshy pulp, a single shiny, brownish seed, and it ripens in September.

Bumelia ought not to be confused with the native haws, shingle oak, common buckthorn, or wild pears, even though it shares many characters with each of them. It may be distinguished from the red haws in that the leaves are entire, it comes into flower later, and its fruits are one-seeded. From the shingle oak (*Quercus imbricaria*) it differs in its smaller, fascicled leaves, cream-colored flowers, and fleshy fruits. It may be distinguished from Rhamnus, the common buckthorn, by the position of the flower and fruit; in Bumelia these are borne on wood of the previous year as compared with the current year's wood in the buckthorn. Chittim wood differs from Pyrus by its smaller, more elongate leaves, with entire margins and shorter petioles, its thorns, its smaller, later-blooming flowers, and its small, blackish berries.

Although chittim wood is such a desirable plant for culture in the region of St. Louis, it is not well known horticulturally and almost no nurserymen carry it. Moreover, since seedlings often have long roots, the transplanting of even small ones from the

wild is difficult. In tests at the Arboretum, the plant was found to be easily propagated from seeds.

An experimental study of seed germination.—Seeds of *Bumelia lanuginosa* were collected at the Missouri Botanical Garden Arboretum, Gray Summit, in the fall of 1938. On December 7 of that year 100 of these—50 in each of 2 pans—were sowed in equal parts of sand, peat moss, and loam, and both pans were placed in a greenhouse in which the temperature was 50-60° F. After 6½ weeks had passed without visible results, one pan was removed to a warmer range (temperature 62-75° F.) to determine if temperature had any effect on their germination. At about

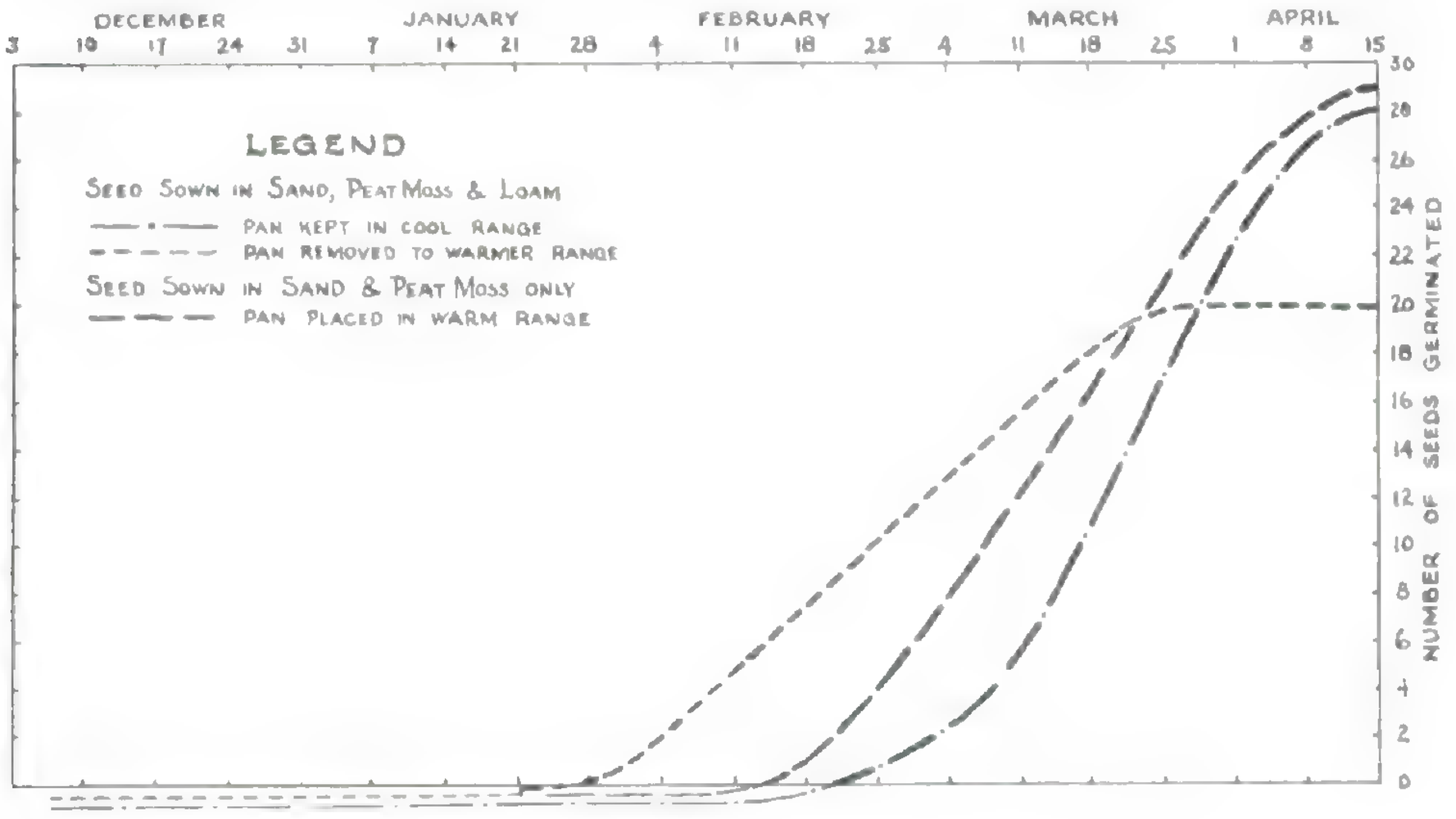


Figure 1

this time, 50 more seeds were sowed in a mixture of two parts of sand to one part of peat moss in order to learn whether or not germination was affected by the kind of soil.

The first seedling appeared within one and one-half weeks after the pan was removed to the warmer greenhouse. Germination proceeded at the rate of about three new seedlings a week for seven weeks, until 21 seedlings had germinated, or 42 per cent (see fig. 1). It was not until the eleventh week that the first seedling appeared in the pan that was left in the cooler range. The rate of germination here was more rapid for a period also of seven weeks. In this case 28 seedlings, or 56 per cent germinated.

In the third pan the time between sowing and germination of the first seedling was shortened to four weeks. Germination was rather constant for eight weeks, until the count was 29 seedlings, or 58 per cent.

When the seedlings were transplanted to 2½-inch pots, on April 15, 1939, typical specimens of the various groups appeared as shown in figure 2.

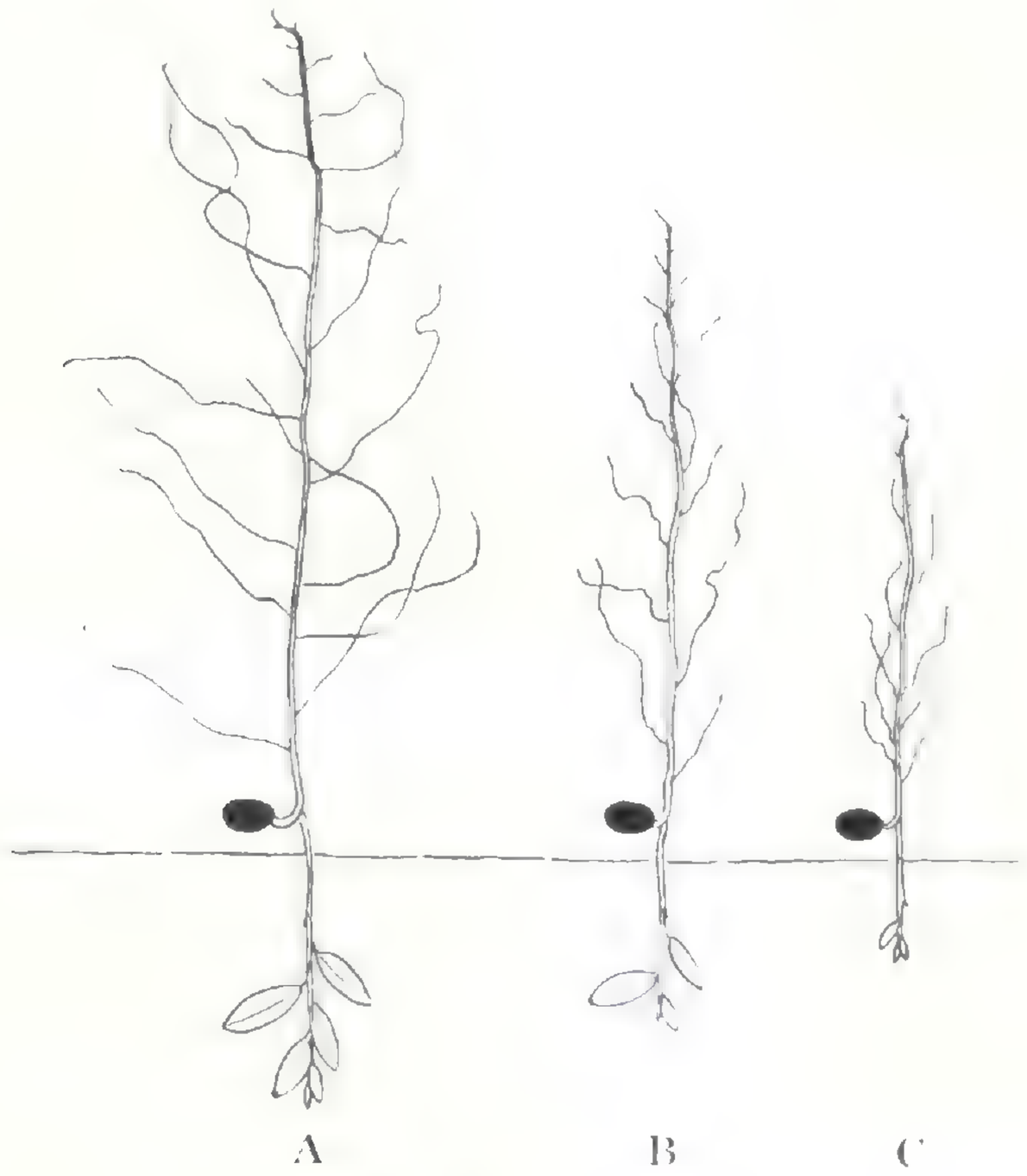


Figure 2

A and *B*, seedlings germinated in soil mixture consisting of equal parts of sand, peat moss, and loam. *A*, from pan kept in cool greenhouse (55-60° F.). *B*, from pan moved to warmer range (62-75° F.). *C*, seedling germinated in soil mixture consisting of equal parts of sand and peat moss, and placed in warmer range. Drawings 2/5 natural size.

Culture.—Bumelia may be found growing on the glades of the Ozarks south of the Missouri River, in the same environment as the red cedar. The berries should be gathered in late September

or early October, before the birds have dispersed them. When they are thoroughly dried and the pulp has become hard and wrinkled the seeds may be removed by soaking the berries for a few hours in water or chipping away the pulp with a knife. Germination may be accelerated by cutting a small portion of the hard shell of the seeds at the end opposite the scar, but this is optional. The seeds are now ready for planting. Too copious amounts of water during germination may prove disastrous.

The type of soil best suited for the development of Bumelia seedlings is a mixture consisting of two parts of sand to one part of peat moss. Keep the seeds moist and in darkness until germinated. The first seedling ought to appear during the fifth week, when given slight bottom heat and kept at a temperature of at least 62° F. at night (in winter) and not above 75° F. during the day.

After a week or two the seedlings may be transplanted to a richer soil containing equal parts of sand, peat moss, and good garden loam, and placed in 2½-inch pots. At this stage the root system ought to comprise a long tap-root, 4-6 inches in length, and numerous lateral fibrous roots. The seedlings may be "hardened off" out of doors only after all danger of frost has passed. At first, they may require covering during very chilly nights and also a shade during bright or hot sunny days. Towards autumn, however, they will be ready for setting out in the nursery row. If raised in a climate similar to that of St. Louis, they will not of necessity require winter protection although covering may be given them. Incidentally, Mr. Alfred Rehder, writing in Bailey's "Standard Cyclopedia of Horticulture," notes that chittim wood has "proved hardy in sheltered positions at the Arnold Arboretum," at Boston, Massachusetts.

Summary.—Bumelia, commonly called chittim wood or woolly buckthorn, is a shrub or small tree worthy of cultivation on account of (1) its resistance to drought, (2) its dependable performance throughout the year, (3) its hardiness in regions whose climate approximates that of St. Louis. It is admirably suited for the sunny courtyard. Finally, although it is not too well known horticulturally, it can rather easily be grown from seed.

ROBERT CLARK.

NOTES

Mr. L. P. Jensen, Manager of the Garden Arboretum, has been re-elected president of the Henry Shaw Gardenway Association.

Mr. George H. Pring, Superintendent of the Garden, spoke before the Men's Club of Tyler Place Presbyterian Church, December 1 on "Breeding of Tropical Water-lilies."

Dr. Carroll W. Dodge, Mycologist to the Garden, gave a lecture on "Public Health Problems in Central America" at the School of Medicine of Washington University, on December 4.

Dr. Hermann von Schrenk, Pathologist to the Garden, spoke before the Wednesday Club of St. Louis, November 6, on "Pacific Coast Trees."

Mr. Ladislaus Cutak, in charge of Succulents at the Garden, has an illustrated article, "Des Moines Cactus Club Celebrates a Milestone," in the November number of *Desert Plant Life* (**12:** 168-172).

Mr. Paul A. Kohl, Floriculturist to the Garden, spoke over Radio Station KSD, on the adult education council program, describing the Chrysanthemum Show and other Garden floral displays.

Mr. George H. Pring, Superintendent of the Garden, has been awarded the Thomas Rowland medal of the Massachusetts Horticultural Society, in recognition of his success in producing tropical water-lilies. This is the medal awarded annually for the most outstanding work in plant breeding.

The December issue of *Real Gardening* (**3:** 49-57) contains a paper, "Some Fundamentals of Good Rose Growing," by Mr. Paul A. Kohl. This is a reprint of most of Mr. Kohl's article, "Growing Roses in St. Louis," from the February, 1939, Garden Bulletin.

The fourth number of Volume XXVII of the Annals of the Missouri Botanical Garden has recently been issued, containing "A Monograph of the Genus Calochortus" by Marion Ownbey, and "Observations on the Cultural and Pathogenic Habit of *Thielaviopsis basicola* (Berk. & Br.) Ferraris," by Ralph Edmund Rawlings.

Dr. George T. Moore, Director of the Garden, has given the following talks recently: November 30, at the luncheon meeting of the Science Teachers' Section of the Private Schools Association of the Central States; December 4, over Radio Station KFUO, "Henry Shaw, Prophet and Philanthropist"; December 6, before the Oklahoma Academy of Science, at Norman, Okla., "On Being Scientific"; December 11, over Radio Station KFUO, "Botanical Gardens Yesterday and To-day."

Recent visitors to the Garden include the following: Mr. R. E. Birch, member American Cactus Society, Pittsburgh, Pa.; Mr. Albert L. Little, Jr., of the Forest Service, Flagstaff, Ariz.; Dr. John T. Buchholz, Head Department of Botany, University of Illinois, Urbana; Mr. Edgar L. Evinger, of the Soil Conservation Service, Washington, D. C.; Miss Patricia Young, graduate student, University of Kentucky, Louisville; Mr. E. L. D. Seymour, Horticultural Editor, *American Home,* New York; Dr. Harry J. Fuller, Assistant Professor of Botany, University of Illinois, Urbana; Dr. John B. Routien, Instructor in Botany, University of Missouri, Columbia; Mr. William C. Leavenworth, Assistant in Botany, University of Illinois, Urbana; Mr. William Dickinson, Field Supervisor, Bureau Entomology and Plant Quarantine, Washington, D. C.; Mr. Bert O. Brayton, Associate Entomologist, Missouri State Department of Agriculture, Jefferson City, Mo.

STATISTICAL INFORMATION FOR NOVEMBER, 1940

Garden Attendance:

Total number of visitors	41,060

Plant Accessions:

Total number of plants and seed packets received as gifts	1,325

Library Accessions:

Total number of books and pamphlets bought	16
Total number of books and pamphlets donated	132

Herbarium Accessions:

By Purchase—

Degener, Otto—Plants of Hawaii	105
Hinton, George B—Plants of Mexico	600

By Gift—	
Philadelphia Academy of Natural Sciences by Leslie Hubricht —Plants of North Carolina	5
Anderson, E.—Plants of Florida, Illinois, and of horticulture	11
Baldwin, J. T., Jr.—*Galax aphylla* L. from southeastern United States	52
Bennett, F. L.—Plant of Nebraska	1
Dixon, Royal—Plants of Texas	2
Hubricht, Leslie—Plants of Illinois and of horticulture	9
James, Leslie—Plants of Alabama	2
Murrill, W. A.—Plants of Florida	40
Nearing, G. G.—*Parmelia aurulenta* Tuck. from New Jersey	1
Pring, George H.—*Vandopsis lissochiloides* Pfitz. from horticulture	1
Stark's Nursery—*Morus alba* var. *skeletonia* Schneid. from horticulture	1
University of Colorado Museum by Joseph Ewan—Plants of Colorado	24
By Exchange—	
Arnold Arboretum, Harvard Universty—Plants of China, North and Central America, and India	2,638
Brooklyn Botanic Garden by H. K. Svenson—*Senecio Crawfordii* Britt. from Tennessee	1
University of Wisconsin by N. C. Fassett—Plants of Wisconsin	154
By Transfer—	
Hubricht, Leslie—Plants of horticulture	9
Pring, George H.—*Cattleya Rex* O'Brien from Horticulture	1
Total	3,657

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NOTICE

ATTENTION is called to the recently issued "Spring Flora of Missouri" by J. A. Steyermark. About fourteen hundred plants blooming in Missouri and adjoining states are described and most of them illustrated. Designed primarily for nature-lovers, scouts, amateur botanists, etc., emphasis is placed on the common name; also, an attempt is made to write the descriptions in simple untechnical language so that, with the help of the keys and the illustrations, identification of spring-blooming flowers should not be difficult. The book is cloth-bound and comprises 590 pages, 163 plates, and 444 line drawings. For sale by the Missouri Botanical Garden. Price $3.00.